Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXII. JUNE, 1922 No. 6

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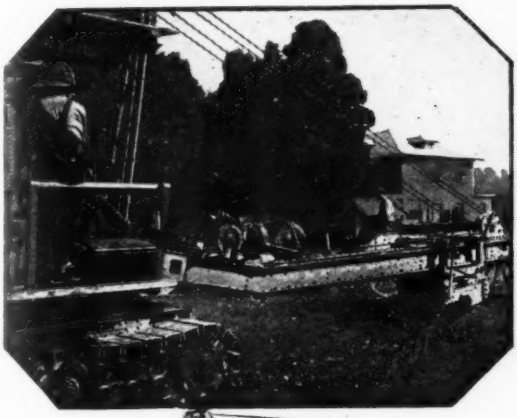

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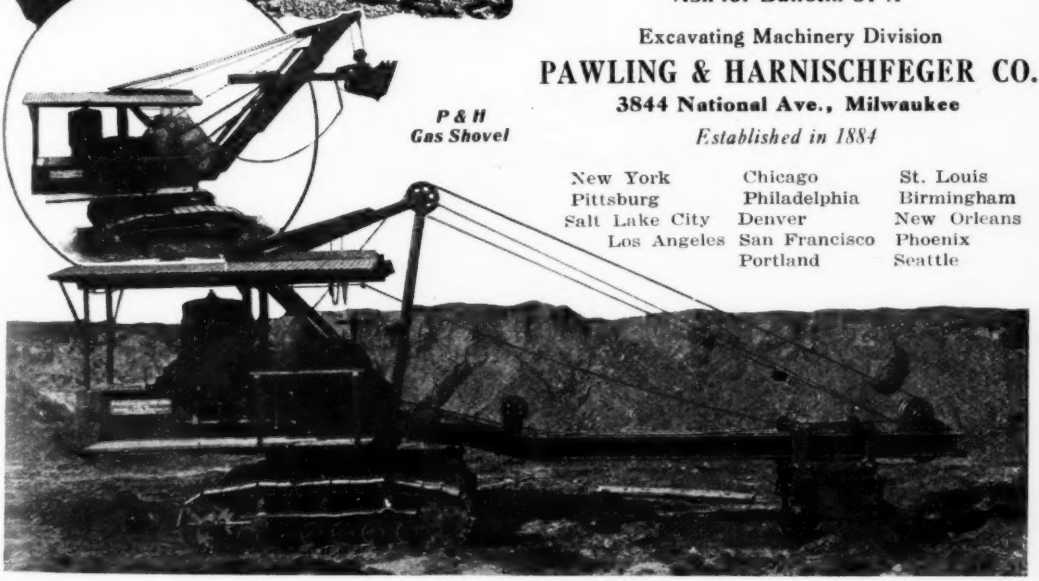

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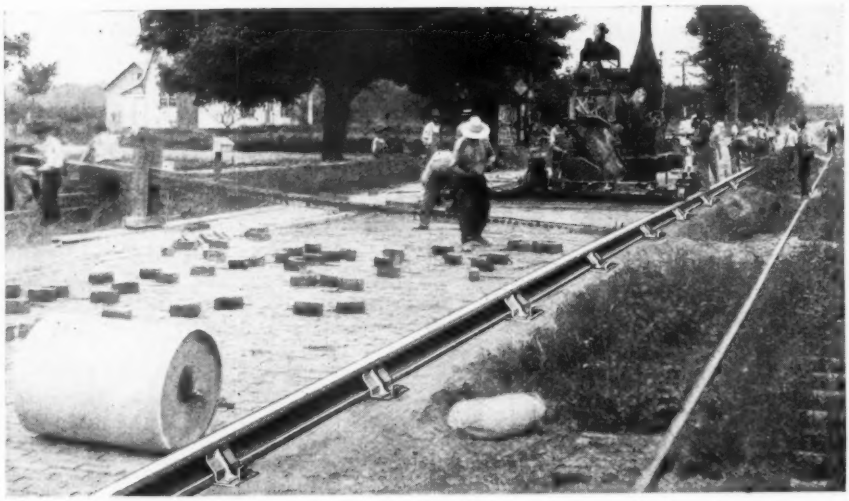

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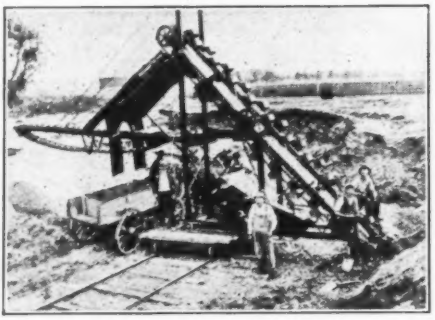

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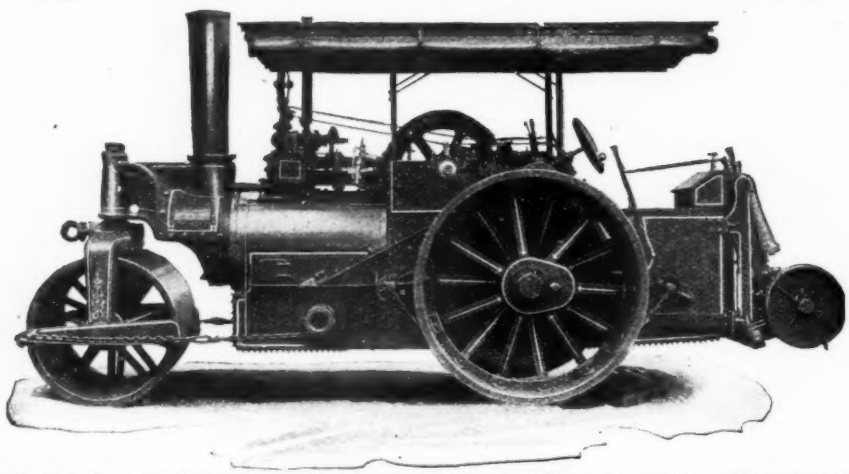

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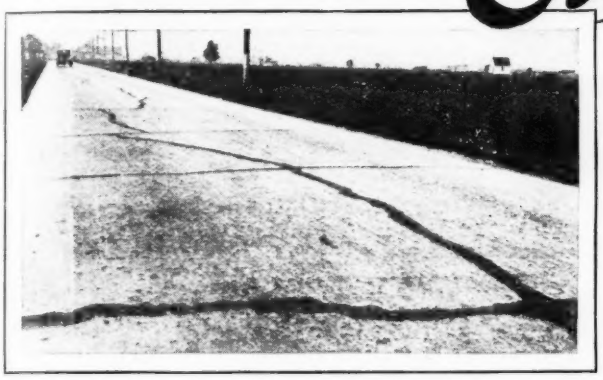

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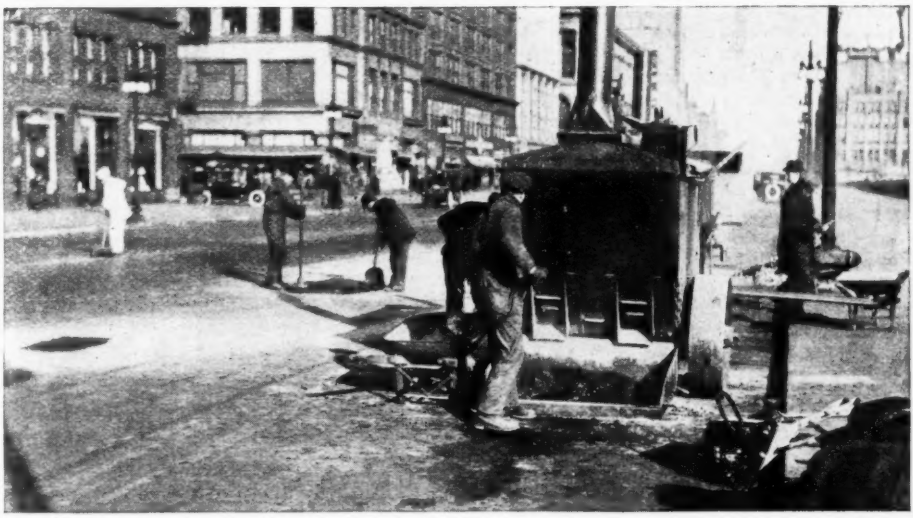

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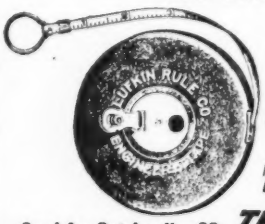

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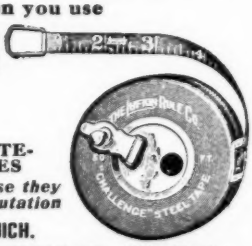

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Motor Truck Operation and Accounting—82

THE HIGHWAY TRANSPORT CLEARING HOUSE

By Tom Snyder, Transportation Building, Indianapolis, Ind.

(Editor's Note: Following is the progress report of the committee of which Mr. Snyder is Chairman as presented at the meeting of the National Highway Traffic Association held in New York City on May 12, 1922.)

Let us determine first just what is meant by the term "Highway Transport Clearing House."

In analyzing the service of Inter-City Motor Express from 12 industrial centers in the United States, many stages of development in the method of soliciting, collecting and clearing freight for motor transport are found.

The process of development is about as follows:

First—The individual operator, who operates one or more trucks, picks up all shipments at shippers' platform, delivering direct to consignee, securing his business through personal solicitation of shipper and consignee.

Second—The individual operator who uses his garage or provides an especially arranged terminal requiring shippers to bring all shipments to such building from which he delivers direct to consignees over one or more highways, securing his business by a personal solicitation of consignees along the route over which he operates, offering store door delivery free for an order by the consignee upon the shipper to ship all orders via his truck line.

Third—A group of operators who render service over different highways and who jointly employ one or more freight solicitors who solicit business from shippers and consignees at terminal ends and intermediate points.

Fourth—The most definite and most successful application of motor transport is found where such groups have also provided station buildings at terminal ends and at intermediate points.

Let us agree then that a highway transport clearing house is an established station from which highway transport shipments can be cleared from the shipper to the transportation trucks, operating over any or all highways over which transportation service is being rendered. That it is a centralizing station to which jobbers, manufacturers, merchants and every variety of shipper can bring his consignments, big or little, and from which station, Rural Motor Express Trucks, Inter-City Motor Express Trucks, Highway Transport Trucks, load and depart according to route schedules, or special service arrangements and it is also a station to which agricultural products, eggs, poultry, butter, cream and other commodities can be consigned by farmers and cleared to consignees, be they individual citizen, merchant, jobber or manufacturer.

The service of a motor transport clearing house will be to meet the fluctuating demand for motor transport, to fix rates, determine classfications, maintain schedules and to educate the shipper, the consignee, and the general public as to the advantages of this type of transportation.

A few years ago the "Highway Transport Clearing House" was considered a possible future development in highway transportation. Today it is seen by all those who try to apply dependable motor transport service, as an absolute necessity.

It can be safely said that Inter-City Motor Express, or Rural Motor Express cannot be generally and successfully applied except through the service of a motor transport clearing house.

The successful operation of one, two or three trucks from some shipping center out to some rural community or to a number of small towns, is but one step in the experimental stage, and is not sufficient evidence of the applicability of motor transport as a definite system of transportation.

The big question coming from the shipper, the consignee, the public and the railways today is, can the highway and the motor truck take the short haul L. C. L. freight off the hands of the railways?

Even if the answer is yes, with the provision that time for its proper development must be allowed, it immediately suggests system, uniform methods, and crystalization. We cannot build confidence, nor can we hold confidence already developed by telling the shipper that he can have motor transport service over the Jackson highway, but not over the

Lincoln highway, that the carrier rate over the Jackson highway is 2 cts. per 100 lbs. per mile on first-class, with a varying rate for lower classifications, while the carrier rate over the Great Lakes highway is 1½ cts. per 100 lbs. per mile, with no classifications, that there is no store-door delivery charge on shipments over the Bingo highway, but that such a service fee is collected on shipments over the Johnson highway.

We can no longer satisfy the shipper or consignee with the fact that truck operator Jones, who, though he is responsible financially for the goods turned over to him, also carries a dependable cargo insurance policy, while operator Smith is not responsible and is also without insurance, but that Smith hauls for a lower rate than Jones.

The greatest need in the development of motor transport as a dependable transportation service out of all American Industrial centers is the establishment of motor transport terminals and clearing houses.

Splendid service is being rendered between many cities throughout America, and this, often, where the keenest kind of steel rail competition exists, while many rural communities in great need of motor transport service, are not served.

Many routes have been established between communities where steel rail service is far below the transportation demands, but much of the service now being rendered, good or bad, is but blind adventure.

Classifications as established by the common carriers are rarely observed by the motor transport systems, the nonobservance of such classfications already established being the cause of the failure in many transport adventures.

These and many other barriers to the practical application and industrial economy of motor transport could be quickly overcome through a motor transport clearing house.

A clearing house is a centralizing point of activity where ideas and methods can be cleared as well as tonnage, and highways transport is now waiting the stabilizing influence of uniform and dependable methods.

Clearing houses and the clearing house system in all freight clearing centers are of constantly increasing importance, and as time and economy in clearing shipments are being recognized as the major portion of the transportation problem, the motor transport terminal comes rapidly to the foreground as a tremendous factor in the entire scheme of transportation.

The major portion of all shipments are consigned to a place, and not to the consignee, and though the consignee may be a farmer or a rural merchant, within a few miles of the freight terminal, and though this distance may be but a fraction of the transportation distance, it is very often the most expensive leg of the service, both in time and money because a very definite interruption takes place when consignment reaches the terminal, at nearest point to destination.

This interruption takes place because the rail or motor service feels that its responsibility ends at its terminal and the consignee is expected to complete the transportation service, with the result that terminal congestion, embargoes and delays are adding millions to the cost of transportation.

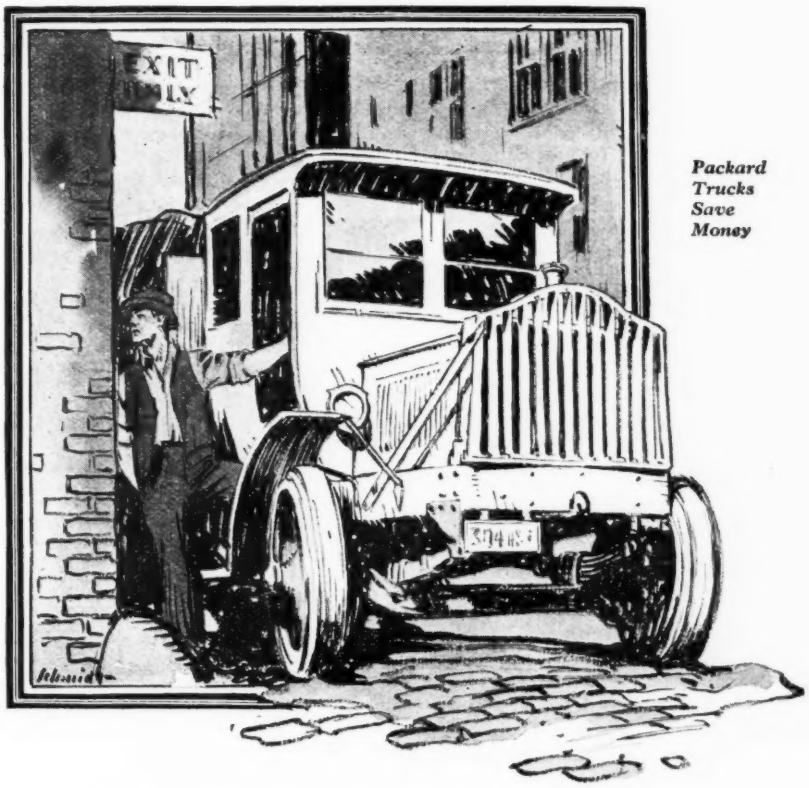
Store-door delivery is now being considered by many of America's largest shippers as a means of providing a continuous transportation service from shipper to consignee, and to provide that the service be extended to all consignees within motor distance or rail or water-way terminals.

Store-door delivery as a relief to terminal congestion, and its many kindred evils immediately involves the application of highway transport as the service could profitably and practically be extended to consignee 40 or 50 miles away from terminal and to farther points if no rail service is available.

With the adoption of store-door delivery service, motor transport clearing houses would become an absolute necessity, and with the establishment of motor transport clearing houses, the conecting link between all methods of transportation would be quickly welded.

The pick-up at shipper's platform methods, makes motor transport a random service, and subjects the truck operator to many delays due to shipments not being ready when he reaches shipper's platform, as truck operator has no control over shipping departments, and as limited platform space may cost him many delays, he has no chance of fixing schedules for reaching shipper.

The pick-up at platform method prevents operators from loading consignments to truck and provides for an unloading order as his last consignment picked up might be consigned to the last stop on his route, or the reverse.



Packard Trucks Save Money

It is perfectly plain that the Packard Truck never could have attained outstanding leadership were it not a sound, saving investment, from every viewpoint of truck operation.

The comparatively low purchase price of Packard Trucks—generally lower than prices of other trucks of comparable quality—adds great emphasis to Packard value.

The seasoned and stable organization building the Packard Truck will continue to advance and fortify still further its leadership and its reputation for lower-cost haulage.

ASK THE MAN WHO OWNS ONE

Packard Service

In 585 Cities and towns throughout the United States, Packard Truck Service stations give owners highly skilled service at a reasonable cost. Packard Truck costs, always low because sound, Packard construction minimizes need of repair, are held still lower by this expert, broadcast service.

Packard Trucks range in capacity from 2 tons, to 7½ tons; and in price from $3,100 to $4,500

PACKARD MOTOR CAR COMPANY, DETROIT

PACKARD TRUCKS

The theory that all shipments to be transported by motor truck can be picked up at the shipper's platform by the transport truck, and that the highway transport truck can also deliver to store door, or be successfully applied as a cartage vehicle, must be given up.

This statement may excite considerable opposition, because so much has been said and written about the motor truck rendering a service direct from shipper to consignee and that because of such service unnecessary handling of freight has been saved.

I know of no important industrial center in America from which (within the next six years), less than 8 different motor transport routes will be operated and from some centers this number may be increased to from 20 to 30.

It would be a daily occurrence for some shippers to have consignments for each of these routes, and limited platform space would prevent the transport truck from each of these routes, picking up their route consignments.

Many shippers have said that they would gladly use motor transport for all short haul consignments if their shipping departments could load motor transport consignments to their own freight delivering vehicles, to be dropped off at a motor transport terminal while making daily deliveries to all other terminals.

As evidence of the need and constructive advantages of motor transport clearing houses, Indianapolis no doubt offers the best illustration in America.

Motor transport routes have been operated out of Indianapolis for the past 8 years and up to the summer of 1921, 9 operators out of 10 went down in failure and defeat.

Indianapolis has 7 steam and 12 electric traction lines radiating from it in all directions, and the successful application of motor transport with such competition requires system.

In 1920, a clearing house system was organized and began the work of standardizing motor transport, fixing routes, establishing schedules, fixing rates, adopting a uniform bill of lading and freight receipt, with the result that commencing April 15, 1922, 10 definite Inter-City Motor Express routes, all operating out of one terminal freight house, and under the direction of one clearing house, each route being handled by one or two different operators, were put into service.

The shipments for all of these routes are solicited by a personal and telephone canvass through the clearing house, and it is the rare thing to find any of these trucks leaving the city with less than a capacity load.

Some of these routes are sustaining four trucks, five of them having an operator at each end, which plan will be adopted on each route.

Providing for an operator at the terminal end of each route solves the terminal distribution problem at these route terminals and adds materially to the resources for meeting emergencies.

The route or intermediate terminal operated by responsible cartage or commercial warehousemen, located at the terminal, has solved the problem of the return or intermediate loads.

The local cartage man, furniture or commercial warehouseman at intermediate points, find it profitable to represent a route operator at such points, as the local shippers use their service in sending shipments to terminal to be picked up by the transport truck.

The great advantage to the transport operator is the fact that he can make and keep schedules.

Another great advantage is an increased volume of business which the local man can secure for him, also the terminal higher established rates paid for the intermediate shorter hauls increases his tonnage income.

The established first-class rate for a 50-mile haul is about 50 cts. per 100 lbs., but if shipments are delivered and picked up at two intermediate points 15 miles apart, the rate is increased on the several shipments to $1 per 100 lbs. for the 50 miles.

The transport operator unloads a portion of his cargo to local terminals taking on additional consignments for other points along his route and pays 10 cts. per 100 lbs. for this terminal service, the terminal operator receiving a store-door delivery fee in addition.

The central clearing office and freight soliciting department is sustained by a fee of $1 per ton, which is paid by the operator.

Insurance covering every possible loss to shipper or consignee, excepting pilferage, is paid by the operator at the rate of 12 cts. per $100 value.

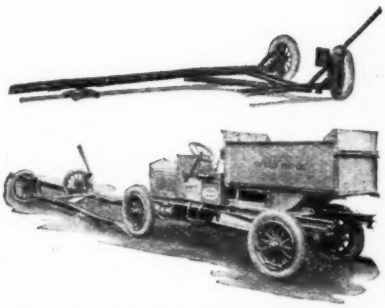
The following rates are collected to which is added a store delivery fee of 25 cts. for each stop and 5 cts. per 100 weight.

	1st Class	2nd Class	3rd Class
1 to 5 miles.....	.32	.27½	.21½
6 to 10 miles.....	.34½	.29½	.23
11 to 15 miles.....	.35½	.30	.24
16 to 20 miles.....	.38½	.33	.26
21 to 25 miles.....	.40½	.34½	.27½

HUG ROAD BUILDERS EQUIPMENT

CONSIDER THESE FACTS

Designed and Constructed by a successful road builder. Saves time and Extra labor—speeds up road work—costs less—does the work better.



HUG TRUCK TURNTABLE

Turns a loaded truck on truck's own power in eight seconds. Protects subgrade, no track required. Occupies 7½ feet wide on road, allowing ample clearance for trucks to pass out. Light and portable, can be moved by two men. Speeds up job. Requires fewer trucks. Eliminates delays. Provides more yardage. Two sizes. For Ford ton trucks, $330. For 2½-ton trucks, $440. Prices f. o. b. Highland, Ill.

Let us tell you also about the HUG SPEED TRUCK

Hug Equipment sold direct to Contractors. Write for Descriptive Circulars.

MEN WHO KNOW BUY HUG EQUIPMENT

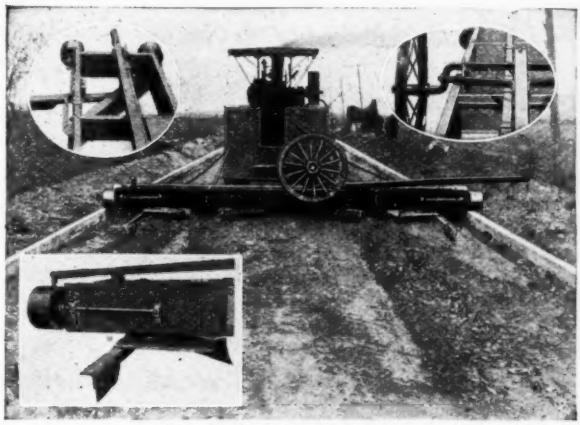
HUG SUB-GRADING MACHINE

LABOR SAVER—CONCRETE SAVER—MONEY MAKER

Saves the labor of ten men per day. Pays for itself on first half mile. Trims the subgrade true to grade which meets any inspector's approval. Cutting depth is easily adjustable. Special crank axle and wheels provide easy transportation. Makes smooth flat or smooth crowned subgrade. Sturdily built. Used on industrial and truck haul jobs. Extra set of grader blades furnished with each machine.

Price for 18 ft. road size $450, f. o. b. Highland, Ill.

Coulter device, shown in insert in lower left side of cut, serves to keep machine in alignment, protecting the forms from side pressure.



Hug Subgrading Machine

THE HUG CO.

Manufacturers Road Builders Equipment **HIGHLAND, ILLINOIS**

LITTLE GIANT HIGHWAY BUILDER

The Packard of the Tractor World

Compares favorably in design, material and workmanship with best automobile or motor truck made.

Three forward speeds—cuts working time in half when load is light. Three point spring mounted suspension, fits it for work on rough or uneven surfaces.

Enclosed spring drawbar, prevents damage to tractor or its load by jerk in starting or while in motion.

Internal ring ball gears—clean perfectly under all conditions. Completely enclosed from weather.

LITTLE GIANT COMPANY, Established 1876
232 Rock St. Mankato, Minn., U.S.A.

ACME

Manholes, Catch Basins, Inlet Basins, Park Basins (All Styles)

Regular and Special Grates or Strainers for Sewer Pipe

Building Columns of All Descriptions

Send Us Your Specifications

MADISON FOUNDRY CO.

927 Addison Road, CLEVELAND, OHIO.

Vocational Truck Selection

It is the opinion of many in the truck industry that truck buyers will pay increasing attention to the service rendered by trucks in any specific field in buying trucks to use in that field. Of course this is a natural method of selection but many buyers in the past have not paid particular attention to the performance of truck types in their field before placing their truck orders.

It is held by many that within the next very few years the great majority of all trucks sold will be sold on the **Vocational Plan,** because the public will insist on being shown just what trucks have done and will do in actual operation in the line of business in which the buyer is engaged and not in some outside line.

It is now possible for prospective buyers of trucks to secure detailed and accurate information regarding truck performance in every field.

We can assist you, without charge, in selecting trucks that have made good in the municipal and county construction field if you so request.

Municipal and County Engineering

702 Wulsin Bldg. **Indianapolis, Ind.**

This man took advantage of the offer on the opposite page. Read what he says about our Truck Advisory Service

"I beg to acknowledge receipt of your letters of May 2nd, May 4th and May 9th, enclosing data regarding the hauling of timber for general mining purposes which I requested of you in my letter of April 21, 1922.

"The information you have furnished me is proving very helpful to us and will greatly assist us in determining the cost of transportation and the proper make of truck to use in our work.

"I wish to thank you for the information you have furnished me and the assistance you have given in helping us to solve our problem."

We have done as much for others and will do as much for you.

Municipal and County Engineering

26 to 30 miles.....	.42	.35½	.28
31 to 35 miles.....	.45	.38	.30
36 to 40 miles.....	.46	.39	.31
41 to 45 miles.....	.48½	.41½	.32
46 to 50 miles.....	.51	.43½	.34½
51 to 55 miles.....	.52	.44	.35
56 to 60 miles.....	.52½	.45	.35
61 to 65 miles.....	.53	.45½	.35½
66 to 70 miles.....	.54½	.46	.36½
71 to 75 miles.....	.55½	.47	.37

The central freight station which is a section of a commercial warehouse is sustained by a fee of 2 cts. per 100 lbs. in and 2 cts. per 100 lbs. out or 80 cts. per ton for all freight cleared.

No freight is accepted below the third-class rate, and a special effort is being made by the soliciting department to secure as large volume as possible in first and one-half and double first-class shipments.

A carefully kept record on 10 3½-ton trucks operating over six different routes for a period of 30 days shows an average income of $38.60 per average day of nine hours.

From this income, each operator pays per truck soliciting or clearing house fee $1 per ton $3.50 freight house fee, 80 cts. per ton, $3.20 insurance, $1.30 for average value of 3½-ton load, or a total of $8, leaving him $30.60 per day for a 3½-ton truck.

The plan has worked out so well that the Central Public Warehouse Company, which is now building a new commercial warehouse of 250,000 sq. ft. capacity, has included in its building plans the floor and platform facilities for all Inter-City Motor Express trucks now operating out of Indianapolis.

When separate motor transport terminals are established, large industrial centers with well populated surrounding territory will require an out-bound and an in-bound building or section.

These terminals could be established and sustained as private enterprises and be made profitable through a terminal hundred weight or package fee, to be added to the transportation charge, and through the operation of a cartage system which would be in great demand on pick-ups and deliveries to consignees and from shippers who do not operate their own cartage vehicles and from thousands of individual citizens who through highway transport and motor terminal service will become the direct consignees of agricultural producers.

These terminals should be established and sustained through the co-operation of wholesale shippers' associations, farm federations, and motor transport organizations.

The buildings should be long and narrow providing the greatest possible amount of platform space on each side of building, insuring relief from either building, platform or vehicle congestion.

The building should be divided into route sections, local cartage vehicles delivering to platform on one side of building within route sections according to consignments, these consignments handled through narrow building to out-bound platform for shipment that day, or left within building if scheduled for following day shipment.

The in-bound building or section should be of the same character permitting in-bound transport truck to unload cargoes on one side of building, and local cartage vehicles to clear from opposite side.

Because of the flexibility of motor transport, terminals will be very well cleared daily.

For out-bound terminal, shipments consigned to routes over which less than daily service is rendered, should not be received earlier than one day prior to schedule departure of truck.

Schedules should be established over all routes offering tonnage in exchange for service, the terminal clearing house keeping all shippers informed as to schedules, transport rates and service offered.

As a large volume of the tonnage being transported by motor truck from industrial centers to rural communities is now being loaded at commercial warehouses, and as rapidly developing new sales and distribution methods will increase this volume, your committee on motor transport clearing houses suggest as an important early step in its activities, that this committee recommend to the American Warehousemen's Association, the provision for motor transport facilities in all new commercial warehouses.

Your committee also recommends that the constructive need of motor transport clearing houses as a means of stabilizing highway transportation, be brought to the attention of all interests devoted to, and affected by transportation problems.

POLICY OF NEVADA HIGHWAY DEPARTMENT WITH WORN-OUT MOTOR EQUIPMENT

The following statement of policy of the Nevada State Highway Department with respect to the disposal of worn-out motor equipment, was recently issued by the Departments.

One of the serious problems confronting an organization conducting operations over a wide territory and on a large scale, as is this Department, is the problem of transportation equipment for field work and the disposition of such equipment after it has been worn beyond economic repair. The Department has received, as surplus war material from the Federal Government, many trucks, tractors, autos, etc., some of which were new, but the majority of which were used machines. Oftentimes the used machinery is good for about one season's use; then to repair and keep it in running condition is more expensive than to replace with new equipment. The same condition holds true on equipment purchased new by the Department, the ordinary life of an auto being about three to five years, depending on the type of machine and the character of service on which it is used. Past experience has demonstrated the approximate economic life of machines of various types, and as much as two years ago a policy was adopted of trading in equipment which had reached the limit of economic repair on new equipment of a similar character. A policy of this sort, when founded on absolute incontrovertible cost records, proves a real measure of economy. During the past many exchanges of this sort have been made on Ford cars and trucks, and just recently a 1917 Cadillac car was traded in on a new car of the same make in this manner. We find that when the salvage value of a machine equals one-fourth of its original cost, and its repair to usable condition equals one-half its original cost, with continued operating costs about double that of a new machine, it is good business to turn the machine in on a new one. The lower operating costs within two years will offset the first cost in exchange; the machine still gives two to four years of further economical service, after which it has again reached the condition of the original machine and another replacement is made, and it thus continues as an unending circle.

TOLEDO ENACTS DRASTIC TRAFFIC ORDINANCE

The City Council of Toledo, Ohio, passed the following ordinance (No. 2437), regu-

MUSHROOM TRAFFIC LIGHT
AN ACCIDENT PROOF CAST STEEL
BRILLIANTLY LIGHTED
TRAFFIC MARKER
A unit that is indestructible, and even more conspicuous at night than in the day time.
It has low maintenance expense, no replacements, and is supplied with a Duplex lighting system, insuring constant service.
This unit is in use in over one hundred cities at the present time, giving perfect satisfaction.
The only cast steel unit on the market.
Bulletin on Request
Electrical & Specialty Supply Co.
MADISON TERMINAL BUILDING
Chicago, Illinois

lating traffic in the city of Toledo, on May 8, 1922:

Whereas, the traffic situation in the City of Toledo is dangerous to the public and should be remedied at once, and

Whereas, the subject matter herein provided for constitutes an emergency in that it is necessary for the immediate preservation of the public welfare; now, therefore,

Be it ordained by the Council of the City of Toledo (two-thirds of the members elected thereto concurring):

Section 1. That Section 1343 of the Toledo Code of 1919 be amended to read as follows: The driver of every vehicle shall stop such vehicle and remain at the rear of any street car which is stopping or has stopped at any regularly designated or usual stopping point to take on or let off possengers, so as to allow passengers free passage between the street car and the curb on the right, and the driver shall cause his vehicle to remain until such street car has resumed motion, except at such points at which safety zones are established and are marked by standards or stanchions connected by chains. In such case vehicles may pass street cars so stopping at a speed not in excess of 5 miles per hour, and shall clear the street car at least 6 ft.

Section 1343-A. Safety zones may be established by the Director of Public Safety along any street car line at any regularly designated street car stop; such safety zones shall be marked by standards or stanchions erected in the street and connected by chains, and no vehicle shall pass through said safety zone. Pedestrians shall enter and leave said safety zones from the end nearest street intersections or nearest a cross-walk.

Section 2. That Section 1359 of the Toledo Code of 1919 be amended to read as follows: No person shall operate and no owner thereof riding therein shall cause to be operated on any public highway in the City of Toledo, any motor vehicle or motorcycle at a speed greater than is reasonable and proper, having regard for width, traffic, use and general and usual rules of such road or highway, or so as to endanger the property, life or limb of any person; provided, that a speed greater than 15 miles per hour in the congested district as defined in Section 1290 of the Toledo Code, or greater than 20 miles per hour in other portions of the City of Toledo, shall be presumptive evidence of a rate of speed greater than is reasonable and proper.

Section 3. Any person upon being found guilty of violating any section or part of section of this ordinance, or of Section 1342 of the Toledo Code of 1919, shall be subject to the following penalties: Such person shall be prohibited from operating or driving a motor vehicle or motorcycle on the streets of the City of Toledo, for a period of not less than 30 days nor more than 60 days, and in addition thereto shall be fined not less than $5 nor more than $200, or imprisoned in the workhouse not more than 6 months, or both.

Section 4. Whoever operates any motor vehicle or motorcycle on the streets of the City of Toledo during a period for which said person has been prohibited from operating or driving a motor vehicle or motorcycle under the provisions of this ordinance shall, if convicted of such offense, be imprisoned in the workhouse not less than 10 days nor more than 60 days.

Section 5. If any part of the penalty provided by this ordinance shall be declared to be invalid, it shall in no manner affect the validity and enforcement of the remaining part of said penalty.

Section 6. That Sections 1343 and 1359 of the Toledo Code of 1919, be and are hereby repealed.

Section 7. That this ordinance, being an emergency measure, shall take effect and be in force from and after its passage.

REGULATIONS GOVERNING SPEED, WEIGHT AND DIMENSIONS OF MOTOR TRUCKS

(Editor's Note: Following is the text of the report of the Committee on Regulations Covering Speeds, Weights and Dimensions of Motor Trucks as presented at the recent annual meeting of the National Highway Traffic Association. Mr. Geo. H. Pride, 350 Madison Ave., New York City, is Chairman of the Committee.)

Your Committee has definitely and unanimously determined on the following:

Width, 96 ins., extreme dimensions.
Height, 12 ft. 6 ins., extreme dimensions.
Length, 30 ft., extreme dimensions.
Solid rubber tires, 800 lbs. per inch of tire width, measured at the base of the rubber.
Maximum axle loading, 22,000 lbs.

There still exists a diversity of opinion among the members of the Committee as to the maximum permissible weight per vehicle, the highway engineering mem-

bers refusing to approve the 28,000-lb. maximum, which was the consensus of opinion of the balance of the Committee. At the last annual convention of the Association in April, 1921, this question was referred to the members there assembled, and the convention by a large majority approved the 28,000-lb. limit, the highway engineering members still voting adversely.

The following speeds were adopted:

Weight.	Speeds Country.	City.
4,000 lbs. gross weight..	25 miles	20 miles
8,000 lbs. gross weight..	20 miles	20 miles
12,000 lbs. gross weight..	20 miles	15 miles
16,000 lbs. gross weight..	15 miles	15 miles
20,000 lbs. gross weight..	15 miles	15 miles
24,000 lbs. gross weight..	15 miles	15 miles
28,000 lbs. gross weight..	15 miles	15 miles

We still consider that there is insufficient data available on the use of pneumatic truck tires to enable us to make any definite recommendations concerning them further than to say that the use of pneumatics seems to reduce the force of impact on the road surfaces to a certain degree, and also that experiments seem to indicate that they cause fully as much wear on hard-surfaced roads as do the solid tires, and even more wear on gravel and certain forms of macadam.

Your Committee wishes to say concerning trailers:

The only trailers that should be permitted to operate through congested regions should be so constructed that they would have no tendency to weave from side to side.

Laws concerning the number of trailers which would be permitted behind one tractor should be sufficiently elastic to limit the number to one, where traffic congestion is great, and to permit more than one where such congestion does not exist.

CONSTRUCTING HIGHWAY CURVES FOR TRAFFIC SAFETY

(Editor's Note: Following is the text of the committee report on "Status of the Construction of Highway Curves and Recommended Practice to Increase Safety to Traffic," presented at the recent annual meeting of the National Highway Traffic Association. Mr. H. Eltinge Breed, Consulting Engineer, 507 Fifth Avenue, New York City, is Chairman of the committee, and Messrs. W. G. Thompson and W. M. Acheson are the other members.)

Th e Association adopted as standard practice the resolutions numbered from first to tenth in the report, except that the third, eighth and ninth were *amended* as follows:

Third. That a line about 4 ins. in width, of appropriate color, be painted on the center line of pavement on all curves, both vertical and horizontal. This painted line to be renewed as necessary in order to keep it conspicuous and that it may indicate, to traffic in each direction, the limit of its half width of pavement.

Eighth. That in order to prevent the shoulders adjacent to hard-surfaced pavements from being "gouged out," gravel or crushed stone (1½ and 2½ ins. in size, mixed and filled with screenings) should be placed 2 ft. in width and 4 ins. in depth, on each side, maintained at the level of the pavement. An application of hot tar or asphalt on this gravel or stone will be found beneficial.

Ninth. That for public safety all advertising signs and obstructions along highway routes be eliminated except those erected by direction or permission of officials having jurisdiction over the highways and for public benefit.

Your Committee on Status of the Construction of Highway Curves and Recommended Practice to Increase Safety of Traffic made a Progress Report last year. This year it can offer definite recommendations for your decision, suggestions for your discussion and projects for your consideration.

The importance of safety on the highway, experienced more or less vaguely by all those interested in highway traffic, becomes tangible through definite figures. There are now registered in the United States 10,500,000 motor vehicles. This year's increase to that number is estimated by manufacturers at 1,800,000. The risk to safety lies in the congestion of 90 per cent of these vehicles upon 10 per cent of our roads. This risk we must minimize. That it is at present fraught with appalling loss of human life is evidenced by the casualties from automotive vehicle accidents—a loss yearly greater than is incurred by all other means of transportation combined.

The majority of these accidents of congestion occur under five conditions, all of which road-builders may help to eliminate.

Principal Causes of Highway Accidents

1. Sight distance on curves, both horizontal and vertical, which is insufficient to permit precaution against the other man's reckless driving. Lack of sight distance also increases the accidents at intersecting roads and at railroad crossings.

2. Insufficient width of pavement, especially in congested districts, which increases the number of cars that turn turtle on soft shoulders and hurtle down unprotected slopes.

3. The inadequate, irregular and improper spacing of danger signs, which encourages a general carelessness of their import. Judged by the number of accidents in their vicinity, they are a spur to the recklessness of the joy rider and a consequent risk to his sober brethren.

4. The tendency of detours under traffic to become almost impassable. On heavy-traveled routes traffic going in different directions should be routed over different detours; or if detours are inadvisable on account of dangerous or impassable conditions, the road should be built horizontally a half at a time.

5. Railroad grade crossings. To help prevent accidents to which these and other highway conditions are conducive, we may proceed at four points: First, to secure good design for new roads; second, to promote adequate improvement of old roads; third, to insist upon reconstruction of existing roads at places that have proven especially dangerous, such as grade crossings; fourth, to improve the location of the center line on dangerous curves and elevations. Under these headings the following recommendations are made. They aim to promote the safety of the traveling public as far as impersonal factors can do it, and they aim to diminish as far as possible the personal menace projected by the reckless driver; safety for the careful, with protection from the careless.

Need for Standard Practic

First of all, under the consideration of general safety for traffic, comes the necessity of standard practice throughout the country in respect to placement of danger signals, elevation and banking of curves, widening and regulation of traffic on curves. Standardization in these matters is imperative, because with the completion of transcontinental routes there is increasing interstate traffic. Drivers traveling to remote sections cannot be expected to apprehend distinctions in practice now existing between different highway departments, yet departure in our state from what they have become accustomed to expect in others, is a frequent cause of disaster. There is no real obstacle in the way of this standardization; it is merely a matter of agreement among State Highway officials and motor organizations.

Recommended Practice

Therefore, your committee proposes that you discuss, alter and finally recommend for standard practice the following resolutions in respect to general safety of highway traffic and to special precautions on curves:

First, that on all curves of more than 3 degrees the pavement and inner half of the earth shoulder be banked. This superelevation should vary from zero for a 3-deg. curve to 1 in. per ft. of width for curves of 20 degs. or sharper.

Second, that on all curves of more than 4 degs. the pavement be widened on the inside ½ ft. for each 1 deg. increase in curvature.

The widening and banking on a 4-deg. curve should start at a minimum of 50 ft. before reaching the point of curve and come to the fully widened and banked section at, or very soon after, reaching the P. C. Inversely, the regular section should be reached at a minimum of 50 ft. beyond the point of tangent for a 20-deg. curve; this varying or transitional width should be about 150 ft. long, with proportional lengths for intermediate curvatures.

Third, that a white line about 4 ins. in width be painted on the center line of pavement on all curves, this painted line to be renewed as necessary in order to keep it conspicuous and that it may indicate, to traffic in each direction, the limit of its half width of pavement. (See amendment in introductory note.—Editor.)

Fourth, that all sharp or dangerous curves, either simple or reverse, horizontal or vertical, should be posted about 500 ft. from each end with a sign indicating that danger exists and the direction of curvature. Railroad crossings at grade should be posted in a similar manner.

Fifth, that the National Highway Traffic Association recommend to all legislative committees preparing motor traffic laws that the attempt to pass a motor vehicle while going in the same direction, on a curve, either horizontal or vertical, where the unobstructed line of vision is less than 500 ft., be made a misdemeanor, and that all damages resulting from an accident under these circumstances be placed upon the passer.

Sixth, that the minimum radius of curves be 300 ft. unless prevented by an approach to a bridge not practicable to change or the improvement being on a village or city street, even to the end that new "right of way" should be procured

in order to increase the radius, bearing in mind that the improvement is being made for a long time, and that land values may increase to an extent prohibitive to procuring more right of way.

Seventh, that providing there is sufficient space within the "right of way," earth slopes be carried out with a 4 on 1 slope. If this is not possible, guide rail should be placed on the inner edge of all curves of more than 8 degs. This rail should be kept painted white and be about 4 ft. in height.

Eighth, that in order to prevent the shoulders adjacent to hard-surfaced pavements from being "gouged out," gravel or crushed stone (2-in. and 3-in. size, mixed and filled with screenings) should be placed 2 ft. in width and 4 ins. in depth, on each side. An application of hot tar or asphalt on this gravel or stone will be found beneficial. (See amendment in introductory note.—Editor.)

Ninth, that all advertising and other signs and obstructions along highway routes be eliminated except those exclusively proclaiming "Danger," and posted officially at 500 ft. from the point of danger, as provided in the fourth resolution. (See amendment in introductory note.—Editor.)

Tenth, that a definite sum be set aside annually by each highway department, and a comprehensive plan devised on which annual progress is made, for the elimination of the most dangerous grade crossings.

There are also suggestions and projects for the future that your committee would like to offer as a sort of progress report for your comment and opinion. They are debatable—are they sufficiently valuable to be accepted as working hypotheses to be proved by experimentation?

We believe that to minimize danger the proper highway officials in each community should make a survey of the bridges in that community and determine to what extent, if any, they should be strengthened in order to assure adequate support to increasing traffic. At present, some of us are in daily fear of disaster to heavy motor buses laden with humanity.

We believe that many congested routes should be widened as an economic and satisfactory method to safeguard traffic.

We question whether the increased security to the public and saving of time would not justify the cost of grade separations for traffic at intersecting crossings on heavily congested routes approaching large cities.

NEW HAVEN ENGINEERS HAVE SUCCESSFUL PUBLIC SPEAKING CLASS

To the Editor:

During the early fall of last year the New Haven Chapter of the American Association of Engineers secured the services of a teacher in public speaking and organized a class to meet on each Tuesday night.

Some members of the class were lukewarm and others saw in the work a chance to develop and improve a quality usually sadly lacking in engineers, namely, the ability to make an address clearly, concisely and with force, and to demonstrate their ideas, thoughts and convictions before a body of their peers.

The first few lessons brought out the fact that speaking before a body of men is not the easiest thing in the world. By speaking, I mean speaking and all that goes with it: such as confidence, poise, lack of self-consciousness, delivery, gesture, accenting, inflection, memory, etc., a weakness in any one of these sticking out like a sore thumb.

The class has kept steadily at its work, and at this date it does not seem like the same body of men who stammered and struggled through the first lessons. The members can now arise and make an address the way it should be made. They know what they should and should not do, and they do not feel as though the audience is pitying them and is wishing they would fade out of sight. They can get on their feet before a board of directors, a body of engineers, a public hearing, a civil court, or wherever necessary, and say: "I am in possession of certain facts that are of vital interest to you. They are assembled in my mind. I want to give them to you in a brief and intelligent way, and, what is more, *I can do it.*"

I will leave it to the readers of this article whether or not the average engineer can do this. He may think he can, but can he? I will also leave it to you as to whether such ability is an asset or a liability. Personally, I would not part with the benefit derived from my membership in the public speaking class for several hundred dollars, and that seems to be the sentiment of the other members.

Very truly yours,

William R. Marsden, of The Marsden Co., Engineering Bldg., New Haven, Conn., May 25, 1922.

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EDITORIALS

OPEN HOSTILITY TO HIGHWAY TRANSPORTATION

There are many electric interurban lines in Indiana that carry both passengers and freight. The development of highway transportation apparently has cut down the freight business of these lines, or at least promises to do so. Naturally, the interurban lines will not lose business if they can help it, and no fault can be found with their efforts towards self-preservation so long as they act fairly with the public, but when they frankly appeal to ignorance and blind prejudice in their efforts to discredit highway transportation, they are deserving of severe censure.

Many interurban cars operating on the Indiana lines bear large printed placards reading as follows: "Problem in Economics: Ship by Union Traction and save the highways. If a heavy truck earns 50 cts. per mile and damages the highway to the extent of $1 per mile, and the shipper of freight loses nothing, and the truck owner keeps the 50 cts., and the taxpayer pays the $1, where does the taxpayer get off?"

There are, of course, many fallacies in this hypothetical question propounded by the interurban lines. The damage of heavy trucks to highways is very much less than the value assumed in the question. For example, there are some gravel and stone roads leading into Indianapolis that carry at least 100 trucks a day for 300 days in the year. At the rate of damage assumed in the question these roads would be damaged annually at the rate of $30,000 per mile, but the fact is that these roads are maintained in good condition for less than $1,000 per mile per year. Quite a difference between biased assumptions and the facts in the case!

Other fallacies in the statement lie in the assumption that only the shipper and truck owner benefit by highway transportation; nothing is said of the ultimate consumer who, in the aggregate, makes up the general public. Also, the fact that the shipper, the truck owner and the ultimate consumer are themselves taxpayers is ignored.

However, it is not so much with the fallacies as with the plain intent of the question that we are concerned in this discussion. The plain intent is to discredit highway transportation, in the interest of interurban transportation, by making appeals to prejudice by means of false statements. If road construction can be checked, the development of highway transportation can be checked, and that is the object, or will become the object, of forms of transportation that compete with the highways for business, whenever the competition of the highways begins to "hurt."

We wish again to warn all workers in the highway field, and all who are interested in seeing a dependable and adequate system of highways constructed in the United States, that in safeguarding this great development it is not sufficient to rely on brotherly love alone. As we have before pointed out, the highways represent the purest form of public ownership, while the steam and electric lines represent the purest form of private ownership of public utilities. When these opposing interests clash the privately owned utilities will fight with every available weapon purchasable with gold. One such weapon is publicity calculated to misinform and mislead the public. Another such weapon is the controlled public official, whether he be in the city council, on the county board, in the state legislature, or in the Congress of the United States, who has opportunity to vote against appropriations for road construction or maintenance, on licensing and operating motor vehicles, etc. Our political history proves only too well that many men are willing to accept the financial backing of special interests during a campaign in exchange for later service to these special interests at the expense of the public. If the railways ever really believe, rightly or wrongly, that they will be injured by highway development, they will do all they can to kill the highway movement, and their all is very considerable.

The truth about highway trausportation must be kept before the public or the public will quickly accept as true the false statements issued to injure highway de-

velopment. In Lincoln's famous statement about fooling the people the emphasis is usually placed on: "but you can't fool all the people all the time." It would be much better to place the emphasis on: "you can fool part of the people all the time," and to realize that this part lies somewhere between 99 and 100 percent, unless that which is true is advanced as consistently and as cleverly as that which is false.

Those who believe that highway development is for the good of the country as a whole will do well to be very active and alert in safeguarding this development. They will also do well not to fall too hard for railway propaganda of any kind.

"THE FREEDOM OF THE CITY"

To grant the "Freedom of the City" to an individual is to confer upon him the greatest honor within the gift of the city, next to the election to public office. This is a very old custom and whenever it is applied people are heard to make inquiry as to its origin and meaning. There are variants of the general idea. For example, while the city of New York has granted the Freedom of the City to an even one hundred men and women since the custom was instituted in the year 1702, to others it has granted merely the hospitalities of the city or the thanks of the city. One distinguished foreigner was officially invited to visit the city, but did not receive the freedom. Special tokens have been given to some, and formal receptions and parades have frequently been held in honor of a guest or resident of distinction.

The conferring of the Freedom of the City, now but a form of courtesy, dates back to the custom of making a man a citizen of a Roman city. In the Middle Ages a man was made a "burgher" or "burgess," and the American colonies followed the practice of making men burghers or freemen. To make a man a "freeman" gave him the right to vote, trade, hold office and enjoy all the rights of citizenship. The ceremony, as practiced today, is a tribute to an individual in the name of an entire city; it is purely honorary and has no legal aspects.

A very cosmopolitan group has received the Freedom of the City of New York in the last 60 years. The list includes military and naval heroes of our own and other countries, a journalist, a sculptor, a President of the United States, a king, two princes, a Cardinal, an Archbishop, two professors, and a Marshal of France. Some have been so honored who were prominent in the political life of a foreign country and who loomed large for the moment in the eyes of partially assimilated elements in the population of the city. In one case, that of "Doc" Cook, the Arctic explorer, the Board of Aldermen voted that their action in conferring the Freedom of the City had been "premature," and they demanded that he return the key to the city.

TOURIST CAMPS

Many cities have provided camping grounds for automobile tourists and others have expressed an interest in the subject. An article in this issue outlines the ideal arrangement of such a camp from the viewpoint of the sanitarian and the motorist. It is well to remember that there are other legitimate viewpoints, including that of the hotel man and the local taxpayer. Within reasonable limits these camps are worth while, but it is easily possible to go to unreasonable public expense in providing a place for the tourist to spend the night at a minimum expense to himself.

The average motorist is, perhaps, satisfied with the fatigue and discomforts of the day's travel, and when night comes prefers the accommodations obtainable at a hotel to those provided at even the best camp sites. It would seem wise, therefore, before spending much money on a new camp, to observe how many motorists make use of it. To begin with, perhaps it is sufficient to provide a site of ample size, on high ground, with good natural drainage. Guide signs to the camp should be placed on the roads leading to it. Then if the camp is used and there are indications that improvements in the way of water supply, sewerage, shelter, stoves, etc., will greatly extend its use, the local authorities can weigh the cost of these improvements against the benefits to the community in the form of direct business and general advertising. It is recognized that most communities, like most individuals, derive pleasure from showing courtesies and extending hospitality to the stranger, and this fact is likely to prove more potent than selfish considerations in prompting local authorities to provide camps for automobile tourists.

COMPARISON OF ROAD DRAINAGE BY DEEP SIDE DITCHES AND TILE DRAINS

By Charles M. Upham, State Highway Engineer, State House, Raleigh, N. C.

If we look over some of the earlier highway literature we find that one of the most emphasized details of construction was drainage of the highways. Nearly every one would talk drainage and plan for drainage systems, but when they commenced to construct a road, the drainage system was generally excluded on account of its cost, and this money was usually spent in the construction of the surface. That this was an unwise practice has been only too often proven. Scientific data now available give us more information relative to the regulation of moisture in the subgrade and the practice of stabilizing road foundations.

I think it is safe to say that, at the present time, road surfaces are standardized to a degree, at least, that we can practically be assured of satisfactory results if constructed in accordance with standard specifications. In many roads we have had sections of the road surface break up, while in other places it has proven strong enough to carry the traffic. Investigation has shown that the failure was not due to the road surface itself, but occurred on account of the failure of the subgrade or road foundation. This has led to thorough investigation of this subject, and before very long data will be collected and assembled so that the results of various researches will be made available for practice. It is practically accepted that the bearing power of any soil or subgrade will vary inversely with the amount of water that the soil or subgrade contains. With this fact to work upon it is readily seen that the more water present in any soil the less will be its bearing power or carrying capacity.

Subgrade Soils

The extent of the effect of moisture on any subgrade depends upon the kind of soil in the subgrade, so that it is readily seen that the selection of soils which go to make the subgrade is one of the most important factors in road construction. This detail is many times overlooked. In clay soils it has often been found that the soil nearer the surface of the ground is more satisfactory for subgrade construction. This undoubetedly is due to the fact that the soil has been broken up due to the action of frost, and that the finer material and colloidal matter has been washed out by the rains.

In the South there is what is known as top soil, which is a sand-clay composed of broken down rock, from which the finer colloidal matter has been washed. With the varying effects of moisture on the different materials it can be seen that the selection of soil for a subgrade is very important, and it is absolutely necessary to get a material of low capillary attraction and resulting high bearing value in the top of the subgrade. Many times the mistake has been made of taking all material from cuts and throwing it indiscriminately in the fills, whereas it would be to the great advantage of the road to select the material generally from the top of the cut and place this material on the top of the fill. In that way we would have the better material in the top of the subgrade and this would afford a higher bearing power for the construction of a road surface, which would have the same effect as increasing the depth of the slab.

Stabilizing Subgrades

There may be many methods of stabilizing subgrades. We cannot imagine any road so muddy and unserviceable that we could not build up a subgrade by putting a sufficient number of rocks or crushed stone in the subgrade. We could also go to the other extreme of imagining a subgrade constructed of solid concrete, and there are other impractical methods of stabilizing subgrades, but on account of large mileage of roads which must be built, and on account of the comparatively small amount of money available for road construction, it is absolutely necessary that the most economic means possible be used in stabilizing the subgrade.

It has been found and accepted by road builders that the most economic method of stabilizing the subgrade is simply to take away the water from the road foundation, or, better still, keep the water from getting into the subgrade. Therefore, one of the first principles in road construction is so to construct a drainage or sub-drainage system as to pipe away all springs or water from any source whatever, so that at no time would it be possible for any of this water to enter the subgrade and thus reduce its bearing power.

Keeping Water Away from Subgrade

This can generally be done by constructing ditches parallel with the roadway, the bottom of which are from 10 to 18 ins. below the subgrade or foundation of the roadway. When a road is hardsurfaced it prevents any water from above entering

the subgrade, at least until it has run to the edge of the pavement. The lateral side ditches intercept any water from horizontal capillarity or side seepage. There only remains then the water which rises up through the ground by capillary action. This is the most difficult and expensive water to take care of, and it can readily be seen that on account of the capillary action varying in different solls the selection of subgrade material is very important. It can safely be said that the amount of water drawn up into the subgrade depends upon the supply and the class of material in the subgrade. Generally speaking, the coarser the material the less the capillary action, and also the reverse is true to the extent that the finer the material generally the greater the capillary action, although within certain limits the capillary action in the coarser material is quicker than in the finer material, but the ultimate amount of water raised, and the height it is raised, is not so much in the coarse material as in the fine material. And inasmuch as it is the amount of water present in the subgrade which influences the stability of the subgrade, it can be seen that in selecting material for the road foundation the coarscr material should be selected.

Capillary Water

From experiments performed by the Bureau of Public Roads it has been determined that the capillary water in a subgrade is greatest directly underneath the hard surface slab, which means that the part of the subgrade which should be the most stable is in reality greatly reduced in bearing power. However, the problem is to substitute for this portion of the subgrade a material which is less affected by the amount of water, or which has lower capillary action, which also means, that the water does not rise so high in this particular selected material, and this is another way of saying that the subgrade is more completely stabilized by this selected material, because the amount of water in the subgrade directly underneath the slab has been excluded by the selected material.

Various cross sections of roadways have been designed for the purpose of doing away with these various conditions, and, of course, one of the universal solutions of cross sections is the side ditch, which intercepts any water from the sides, which would otherwise get into the subgrade.

Side Ditch and Underdrain

This brings us up to the comparison of the side ditch and the tile underdrain, which generally consists of a ditch at the bottom of which is a pipe laid with loose joints and then the ditch filled in with crushed stone.

It has been thought best by many that since this was called a drain it effectively drained all the watef from the subgrade, but, undoubtedly, in many soils this drain did little or no good other than to intercept any free water which might otherwise find its way to the subgrade. In other words, it is quite likely that this drain was only effective in taking away free water which came from the surface or seeped through the ground horizontally.

It is quite doubtful if any drain ever carried away any appreciable amount of water which rose by capillary action. Therefore it can be seen that neither the open ditch nor the tile underdrain is sufficient to cope with the capillary water in any subgrade. We must, therefore, design against capillary water in addition to the longitudinal drains.

Location of the Underdrains

In the subject of tile underdains there is a question as to their location. While the longitudinal underdrain will serve the purpose of intercepting water which would otherwise find its way to the subgrade, quite often transverse drains are necessary for the purpose of taking away water from springs or stratas which carry water underneath the road. The number and location of these drains absolutely depends upon conditions, and the amount of water which finds its way underneath the roadway. To carry the question of transverse drains a little further, and to develop the idea more completely, selected material which can be easily drained is some times placed underneath the road surface in thicknesses varying above 2 ins. This material should be connected up by drainable material to the nearest drain or ditch. This is another very effective means of reducing the amount of water underneath the road slab which is a means of increasing the bearing value of the subgrade or road foundation.

The location of a lateral or longitudinal drain has been the subject of considerable discussion. One suggestion is to place the drain directly underneath the ditch, but this seems to be the improper place on account of water flowing in the ditch carrying the finer silt particles into the drain, which gradually make it less effective. It is undoubtedly bettetr to construct the drain higher up on the shoulder and a little nearer the roadway surface.

Chemical Treatment of Subgrades

There are many methods now being devised for the treatment of subgrades in order to overcome the water of capillarity, and to insure more complete stabilization, various chemicals are being used to experiment in the treatment of subgrades. Water-gas tar is a substance which has been used in subgrade experimentation. Other experiments show that Portland cement has an advantage in stabilizing subgrades. Experiments with low capillary material suggests that cinders, sand, gravel, or crushed stone will bring about a stabilized subgrade only in a different manner. In all cases, the treated or selected subgrade material should be connected with the tile drains or ditches or drainage system, by means of the most drainable material, and the subgrade, even if built of selected material, must be so constructed as to drain as completely as possible.

Comparison of Open Ditch and Tile Drain

We are now to the question of the comparison of the open ditch and tile drain. Neither of these is a cure-all. In some instances they help materially, but in other cases their effect is slight. There is a particular experiment which has been watched for several years. It is a surface treated macadam road. This particular road broke up every spring as the frosts came out of the ground. A complete investigation was made and what remained of the macadam surface was cleared away and, although it was expected to find a spring underneath the roadway, the only thing which was found was a layer of clay slightly over an inch in thickness. This layer of clay was slightly tilted to such an extent that water would percolate through the ground until it reached it, and then on account of this impervious clay layer, water would follow along on top of it and appear underneath the road surface. This amount of water on top of the strata of clay so weakened the road surface and subgrade that it broke up each year. It was noticed that this strata of clay was underlaid with a very coarse and easily drained sand, and the water which had collected on the clay strata was easily drained down through the holes cut in the clay strata. This matter is being mentioned to show that the flow of water in certain soils is very slight and that tile drains will have very little beneficial effect in such soils.

In many instances it has been found that the flow of water in different soils varies from 1 ft. a day up to 20 or 30 ft. a day in clay soils. There is some question relative to the depth of drains and ditches. It is very evident that a ditch will intercept water the same as a tile underdrain, and also the tile underdrain will have the same effect in intercepting water as an open ditch. It is assuming that both are maintained. It is quite evident that it is more difficult to maintain a ditch than an underdrain on account of the fact that in tile drains the pipe is always available for the free water, whereas if an open ditch becomes stopped up the free water is backed up and allows a bigger supply of water for capillary action in the subgrade. The deeper the ditch the more difficult it is to maintain, and one more important point is the fact that a deep ditch must be maintained by hand, which should eliminate this kind of ditch from consideration only where the depth of the ditch is necessary for water drainage. In many instances a shallow ditch can be maintained by a road machine.

Effect of Frost on Tile Drains

The value of a tile drain is sometimes completely lost under certain conditions of frost, and in many instances the effectiveness of a tile drain is practically of no value, although there may possibly be a very slight movement of water through frozen ground. This, however, is very slight. In this particular instance, no doubt, the open ditch would be more effective, especially in taking care of any surface water, which through certain weather conditions such as a thaw, might be present.

Probably the most critical time for any road is after the ground has been frozen for some 2 or 3 ft. Under these conditions the effect of the tile drain would be greatly reduced. If this freeze is followed by a thaw the surface of the road is first affected and this condition brings about an excess of water on the surface of the road and directly underneath the slab. On account of the frozen material underneath, the free water cannot pass down into the drain and thus, in this instance, the value of a tile underdrain is reduced to a minimum. A more effective solution in this case is a shallow gutter. By this is meant a gutter from 10 to 18 ins. below the subgrade with the shoulders and slopes so constructed that surface water and any free water occasioned by a thaw can readily find its way to the gutters.

It is assumed that all underdrains and ditches are constructed to grade and will thus quickly carry away any free water. Another very important point is that any free water which might for any reason exist in the subgrade must have a method

whereby it can pass off immediately to the drain or ditch. In the case of ditches the existing conditions must be thoroughly studied before the location and depth is determined. If you are constructing a road on a fill, of course, there is no water to intercept, but in a cut which is on light grades or on side hill work, an intercepting ditch is very effective. On the heavier grades it is not necessary to make the ditch as deep as on the lighter grades, for the grade of the roadway has the same effect as the deeper ditch. If the ditches drain readily, all indications seem to point to the conclusion that it is seldom necessary to construct any ditch deeper than 2½ ft. or 3 ft. below the grade of the road. It is sometimes necessary to do so to get a suitable grade to drain the system.

In summarizing, no distinct advantage can be claimed for the tile drain above the open ditch; nor can it be said that the open ditch is more favorable at all times than the tile drain. But there are certain conditions where a combination of the two will be the most practical. If an open ditch is used there is no advantage in making it any deeper than to intercept water, and should not be so deep that it cannot be maintained by machine; otherwise the maintenance will be a costly item. An open ditch can be used to intercept water as effectively as a tile drain. The open ditch must be constantly maintained and represents a hazard to traffic. On the other hand, a tile drain will serve as well as an open ditch when used to intercept water from getting under the roadway. The maintenance of a tile drain is generally less than the open ditch, although many times its original cost of construction is greater. At no time does the tile drain present any hazard to traffic, and for this reason it should be given serious consideration.

Undoubtedly no decision can be made to the extent of stating that either the open ditch or the tile drain is preferable, but it can safely be said that there are conditions when it is more economic and desirable to use either one or the other. After a careful consideration of all the details it is quite likely that a combination of the open ditch and the tile underdrain is more suitable than either the one or the other.

In no case is it necessary to construct the open ditches or tile drains lower than that point which will intercept water, for, in practically no instance do the drains reduce the amount of capillarity, and after all a combination which will most economically reduce the amount of moisture in the subgrade is the method to be selected, taking into consideration the first cost, cost of maintenance, and giving due consideration to any hazards which might be interposed on account of the open ditch.

The foregoing paper by Mr. Upham was presented before the Eighth Annual Conference on Highway Engineering at the University of Michigan.

THE DISPOSAL OF SEWAGE SCREENINGS

By William F. Morse, Consulting Sanitary Engineer, 1007½ Kee Mar Park, Cleveland, Ohio.

One of the many problems dealt with by superintendents of sewerage plants is the disposal of the screenings that are the invariable accompaniment of all sewerage work.

The daily flow of sewage carries a body of organic and inorganic matters and substances that must be detained and removed before the process of purification can begin.

After passing the grit chamber that detains the more solid parts the sewage passes through a series of screens, vertical, horizontal or inclined, and spaced with openings according to the general character of the sewage. These floating substances are caught and held until the screens become clogged and require cleaning. The daily amount of the screenings varies with each locality and with the seasonal discharge of sewage. When the surface waters, or unauthorized connections are allowed to enter a sanitary sewer system beyond the customary moderate allowance of capacity, there is a corresponding increase in quantity, and there may be a radical change in the character of the screenings. The effect of this is forcefully pointed out in the article on "The Abuse of Sanitary Sewer Systems," in the April issue of Municipal and County Engineering.

There is but little accurate information available in regard to the daily amount of screenings, since this depends so largely upon conditions, as pointed out, but under usual conditions, with the type of inclined screen commonly in use, sewers discharging at the rate of 1,000,000 gal. per day will carry from three to five bushels of screenings. Estimating one heaped bushel at 1¼ cu. ft., and the screenings (as collected) at 75 to 80 lbs. per cu. ft., the daily amount per 1,000,000 gals. would

be 400 lbs. carrying approximately 320 lbs. of water in suspension.

In one city of 900,000 population the daily amount of screenings from two-thirds of the population is estimated at a maximum of 15 cu. ft. per hour, containing 80 per cent liquids and 20 per cent solids. After the screenings are passed through presses at 150 lbs. pressure per sq. in., the expected weight is 60 lbs. per cu. ft., 900 lbs. per hour, and the moisture content is 70 per cent. These estimates are based upon the operation of a smaller sewerage plant in another section of the city.

In a neighboring city of a population of 70,000, with an average daily flow of 1,000,000 gals., the screenings are about 3½ bushels per day. It would appear that the screenings in the normal sewage flow from northern and western cities, where there is no single element or item of unusual prominence in the sewage, there would be approximately from three to four bushels, equivalent to 3.75 to 5 cu. ft. for each 1,000,000 gals.

But when the sewage is treated by a method different from that of the usual type of sewerage plants there may be a wide variation in the liquid and solid constituents of the sewage.

In 1914, the city of Long Branch, Cal., population 30,000, contracted for the installation of the Riensch-Wurl Screen, a German device for the separation of sewage into its liquid, solid and semi-solid constituents. From the combined systems of surface waters and sanitary sewers, the maximum flow of sewage was estimated at 2,000,000 gals., or about 150 cu. ft. per day. The liquid content was expected to be 80 and the solids 20 per cent.

The solids extracted by this method were to be destroyed by incineration, using for the purpose oil fuel at 8 lbs. per gal., at the cost of 70 cents per bbl.

Upon completion of the plant it was found that the daily flow was 105 cu. ft., and that the liquid content was somewhat in excess of the estimated 80 per cent, while the weight was slightly above 75 lbs. per cubic ft.

To destroy the solids an incinerator was designed by the writer and built by the contracting company, under a guarantee that 5 lbs. of oil should incinerate 1 cu. ft. of sludge, in a completely sanitary manner, without nuisance, and with the labor of one man.

This incinerator was a special construction, built under the patents of the writer, and comprised three separate chambers of large area providing for the rapid evaporation of moisture, the utilization of all heat units in the fuel, and apparatus for the complete and final destruction of all noxious gaseous products. The temperatures in the upper chamber averaged 2,200 deg. F.; in the second, 1,600 deg. F.; in the lower, 1,200 deg. F., and 600 to 800 at the chimney flue. The chimney was of radial brick construction, 75 ft. high, and lined to the top with firebrick.

In later years, when the price of oil had increased, natural gas at a low cost was substituted for oil, with a corresponding decrease in operating expense. At this plant it has, moreover, been found that the percentage of liquids in the sludge has become 85-87 per cent, and that the sludge has practically no calorific value.

Screenings contain a mass of decaying organic contaminated matter in its last and most objectionable and threatening form. If taken away for earth burial there is always to be considered the factor of expense for hauling and sanitary supervision. A much better way is to destroy the residuum of a sewage disposal plant by incineration in properly designed, thoroughly tested furnaces.

When the sewerage works have a power plant with a chimney of reasonable height the problem is solved at once by the installation of an incinerator that may be connected with the chimney or with the boiler smoke-pipe. This incinerator occupies a small area of space, in or adjoining the boiler room, as near as possible to the screens, however, in order that the collections may be economically handled, with the least exposure of the employees to contagion. The location, dimensions, capacity and general arrangements should be designed to suit the local conditions.

In large sewerage plants a vertical steam boiler of suitable capacity will furnish power for operating sewage presses, steam-heating for the laboratory or other buildings, or will supply hot water for cleansing and other uses. The boiler may be fired independently of the incinerator when needed, but will depend for usual operation upon the heat from the screenings and the necessary fuel to maintain combustion.

This method of disposal, by self-contained continuously working incinerator, is the most economical, practical, sanitary way of solving the problem of the disposal of sewage screenings of any character, and in any quantity.

THE THRUST IN SKEW ARCHES

By Daniel Royse, 21½-17 Battery Place, New York, N. Y.

Rankine, in "Manual of Civil Engineering," article 295, says:

"Skew arches are of figures derived from those of symmetrical arches by distortion in a horizontal plane. The elevation of the face of a skew arch, and every section parallel to its face, being similar to the corresponding elevation and vertical section of a symmetrical arch, the forces which act in a vertical layer or rib of a skew with its abutments, are the same with those which act in an equally thick vertical layer of a symmetrical arch with its abutments, of the same dimensions and figure, and similarly and equally loaded.

"The angle of skew, or obliquity, is the angle which the axis of the archway makes with a perpendicular to the face of the arch. The span of the archway 'on the square,' as it is called (that is, the perpendicular distance between the abutments) is less than the span or skew, or parallel to the face of the arch, in the ratio of the cosine of the obliquity to unity. It is the span on the skew which is equal to that of the corresponding symmetrical arch."

Hool, in "Reinforced Concrete Construction," volume III, page 43, section 22, says:

"Skew arches may be treated exactly as right arches, the span being taken parallel to the center of the line of the roadway and not at right angles to the springing lines of the arch."

The foregoing quotations comprise the theory and practice of the design and construction of skew arches as presented in the text-books.

Luten, in a pamphlet on "Skew Arches," published in 1921, states a theory, confirmed by observation of expansion joints in the spandrel walls of skew arches built of reinforced concrete, which is contrary to that generally accepted. He says:

"The theory on which the design of such arches is based is substantially the same as for a right arch, except that a heavier thrust is exerted against that end of the abutment at the obtuse angle and should be resisted by a greater mass in that end of the abutment. The placing of the reinforcement is of the first importance, the transverse reinforcement, particularly not following the rule for a right arch."

The writer has sought to develop a method for analyzing the stresses in a skew arch so as to determine how much the resultant thrust is diverted toward the obtuse corners of the arch, with consequent eccentric loading of the abutments.

Consider a skew arch (Fig. 1) with the skewbacks at AB and CD, and with the axis of the arch rib as shown in elevation at A'E'C'. Rib shortening will cause the crown to drop and the rib axis to take the position A'G'C'.

If the arch were cut through the crown and the changes in length and in position

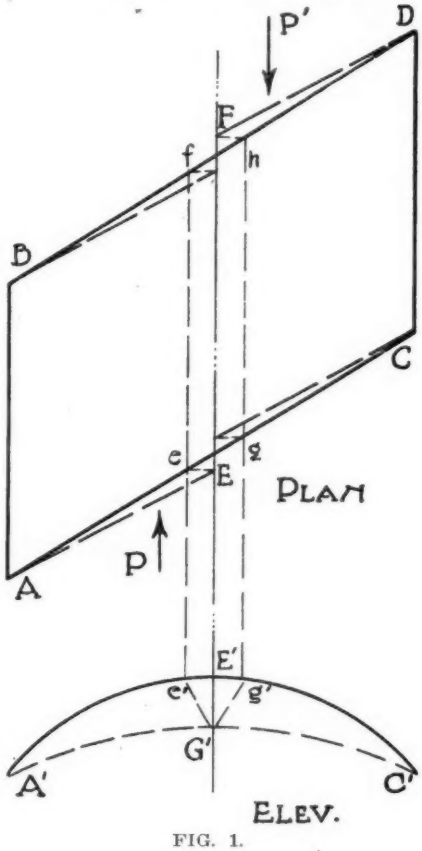


FIG. 1.

taken separately, there would be: First, a shortening of each half of the arch in the direction of the roadway so that the center edges originally both on line EF, are at ef and gh, respectively. Second, bending or rotation about the skewbacks until the center edges are again in contact.

At the crown the two halves do not touch for the entire width, and the plan of the shortened arch rib is as indicated by the broken lines. To bring the faces of the arch into unbroken surfaces again

will require forces applied as indicated by the arrows P and P′, which will increase the abutment reactions at the obtuse corners B and C, as compared with the stresses at the acute corners A and D. If a solid arch be strained as described the equivalent of the assumed forces P and P′ will be set up as internal stresses.

As to how the assumed thrusts, all parallel to the center line of the roadway are diverted to produce an eccentric application of their resultant at the abutment:

Consider the skew arch of obliquity B as made up of separate thin layers parallel to the face, each layer being a narrow right arch, and take two adjacent layers,

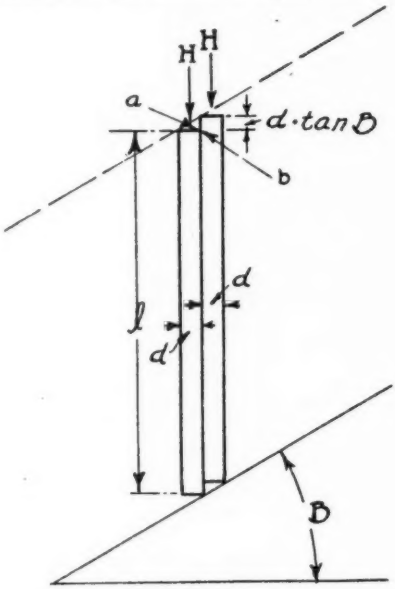


FIG. 2.

each of length l and width d (Fig. 2). Under a stress of H per unit area of cross-section point a will move toward the abutment a distance of (H÷E)l, E being the modulus of elasticity, while point b originally adjacent to a but on the second lamina, will move a distance of only (H÷E) (l—d tan B). Thus point a moves a distance (H÷E) d tan B relative to point b. If point a be fastened to point b as would be the case in a monolithic structure, there would result a transfer of stress from the longer to the shorter lamina. Such transfer of stress from lamina to lamina means greater stress at obtuse corners.

If a concentrated load be supported on a number of separate columns (Fig. 3) of equal cross-section and varying length, the distribution of the load among the column is inversely as their respective lengths, since stress is proportional to unit strain and (the total strain being the same for all columns) the unit strain is inversely as the column length.

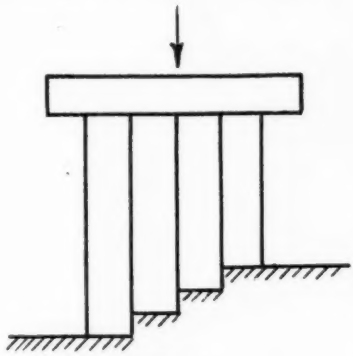


FIG. 3.

If a number of equal loads be imposed on a monolithic support (Fig. 4), the various sections if free from each other would be strained directly as the length of each, but as the sections are connected there is a tendency to equalize the total strains, with increased unit strain at the short end and decreased unit strain at the long end, and if the top of the support as loaded is parallell to its original position the stress developed in each section will be inversely as its length.

If in a skew arch there be a diversion of the resultant thrust to an eccentric

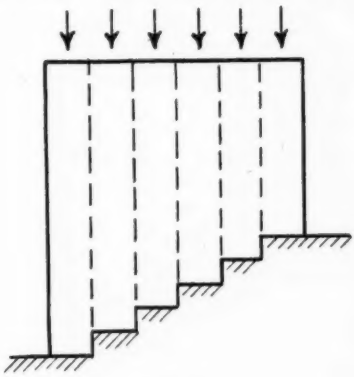


FIG. 4.

position such as T-T′ in Fig. 5, the diversion must be caused by an equalization of the total strains of unequal longitudinal elements under equal thrusts, and there will be some line through the middle point of the crown, as J-J′ in Fig. 5, which has not changed its direction as a result of the straining of the arch,

and applied at which uniformly distributed thrusts will produce equal total strains in the longitudinal elements extending from J-J′ to the abutment. Equal total strains mean unit strains, and hence stresses, inversely as the lengths of the elements.

It should be remarked that the actual thrusts of the arch which are taken as being applied at section J-J′, are equal stresses per unit area of cross-section, since in a properly designed arch the thickness of the arch rib is increased from crown to abutment in the same proportion as the tangential thrust increases relative to the horizontal thrust.

The lengths of the longitudinal elements are to be measured along the curve of the arch, that is measured on the development of the neutral axis and not on the plan of the arch. Lines on the arch which lie in vertical planes parallel to the center line of the roadway and appear in plan as right lines, will be circumflex curves on the development. Strictly, in this analysis the length of longitudinal elements should be measured along the curve of the development but no sensible error results if measurements be made along the chords. Line J-J′ which appears as a right line on the development is a circumflex curve on a plan view.

Fig. 6 is the development of the neutral axis of an arch rib of length=s, length

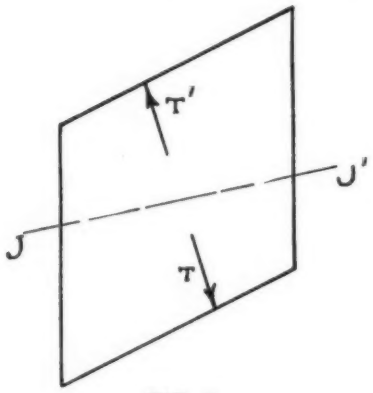


FIG. 5.

of abutment=a, and obliquity (on the development)=C. J-J′ is the datum line at which the actual thrusts are applied, and from which the longitudinal elements are measured; J-J′ makes some angle=E with a perpendicular to the line joining the abutment ends.

From the definition of J-J′, the unit stress, p, transmitted to abutment along any longitudinal element of length l, is $p=(p'\,l')\div l$.

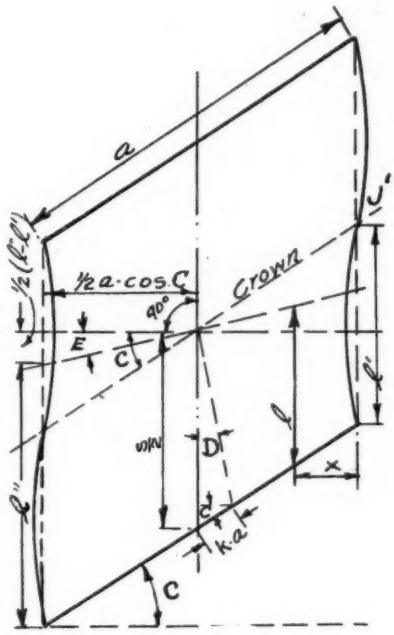


FIG. 6.

From Fig. 6, $l=l'+\dfrac{x}{a\cos C}(l''-l')$ and

$$p=p'\,l'\div\left[l'+\frac{x}{a\cos C}(l''-l')\right]$$

Denote the ratio of l″ to l′ by m. Then

$$p=\frac{p'\,a\cos C}{a\cos C+x\,(m-1)}$$

The thrust transmitted by an element of width dx is

$$d\,F=p\,dx=\frac{p'\,a\cos C}{(m-1)}\cdot\frac{(m-1)\,dx}{a\cos C+x\,(m-1)}$$

The total thrust is the integral of dF between the limits x=a cos C and x=0 and is

$$F=\frac{p'\,a\cos C}{m-1}\cdot\log_e m$$

Taking moments about the obtuse corner, the moment of dF is dM=xdF=pxdx.

$$=\frac{p'\,a\cos C}{(m-1)}\left[\frac{(m-1)\,x\,dx}{a\cos C+x\,(m-1)}\right]$$

$$= \frac{p' a \cos C}{(m-1)} \left[dx - \frac{a \cos C \, dx}{a \cos C + x (m-1)} \right]$$

The total moment is the integral of dM between the limits x=a cos C and x=o, and is

$$M = \frac{p' a \cos C}{(m-1)} \left[\left[a \cos C - \frac{a \cos C}{(m-1)} \log_e m \right] \right]$$

The abscissa of the point of application of the resultant at the abutment will be

$$\frac{M}{F} = \frac{a \cos C}{\log_e m} - \frac{a \cos C}{m-1}$$

or, measured along the abutment the resultant is at a distance of

$$\left[\frac{1}{\log_e m} - \frac{1}{m-1} \right] a$$

from the obtuse corner, and at a distance of

$$\frac{a}{2} - \left(\frac{1}{\log_e m} - \frac{1}{m-1} \right) a$$

$$= \left[\left[\tfrac{1}{2} \left(\frac{m+1}{m-1} \right) - \frac{1}{\log_e m} \right] \right] a$$

from the middle point of the abutment.

The ratio of this distance to the abutment length is defined as the "eccentricity of the resultant thrust" and denoted by

$$k = \frac{1}{2} \left(\frac{m+1}{m-1} \right) - \frac{1}{\log_e m}$$

From Fig. 6,

$$\tan D = \frac{k \, a \cos C}{\frac{s}{2} - k \, a \sin C} = \frac{k}{\frac{s}{2 \, a \cos C} - k \tan C}$$

Also from Fig. 6,

$$\tan C - \tan E = \frac{\tfrac{1}{2} (l'' - l')}{\tfrac{1}{2} a \cos C}$$

$$\frac{l'' - l'}{a \cos C} = \frac{s}{a \cos C} \left(\frac{m-1}{m+1} \right)$$

since

$l'' + l' = (m+1) l' = s$, and $l'' - l' = (m-1) l'$.

Hence

$$\tan E = \tan C - \frac{s}{a \cos C} \left(\frac{m-1}{m+1} \right)$$

The value of the angle E which the datum line J-J′ makes with a perpendicular to the line joining the abutment ends, depends upon the figure of the structure and the physical properties of the material of which it is built. The physical constants involved not being known, it is proposed to assume a relation between the angle E and the angle D, both of which are functions of m, in order to determine m and compute the eccentricity, k.

Any assumption made should be such as will give rational results at the limits between which the figure of the structure may vary. With the length of the development constant, the figure will vary as the obliquity varies, or as the width varies.

Consider the obliquity as the variable: One limit is zero (the arch is a right arch) and then angle D and angle E are equal, each being zero. The other limit for the obliquity is 90 degrees, and as this limit is approached the length of the barrel of the arch becomes very great relative to the span, a figure in which the resultant thrust is normal to the abutment (though the eccentricity is small because of the extreme length of the abutment), and the datum line approximates the line of the crown of the arch; at the limit angle D and angle E are equal, each being equal to the obliquity, 90 degrees.

Consider the ratio of width to length as the variable: When the width is very great the abutment is very long relative to the span and the resultant thrust is normal to the abutment, with angle D and angle E each equal to the obliquity. As the width approaches zero, the thrust must be along the narrow arch rib, with angle D and angle E each equal to zero.

It is believed to be reasonable, therefore, to assume that the angle D and the angle E are equal for the intermediate conditions, and that the two equations involving m may be combined as

$$\frac{k}{\frac{s}{2 \, a. \cos C} - k \tan C} = \tan C - \frac{s}{a. \cos C} \cdot \frac{m-1}{m+1}$$

where

$$k = \tfrac{1}{2} \left(\frac{m+1}{m-1} \right) - \frac{1}{\log_e m}.$$

Then for given values of a, s and C,

TABLE I—VALUE OF K=ECCENTRICITY OF RESULTANT THRUST.

a cos C / s	sin C: (Angle of Skew of Development=C)											
	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
.1	.007	.009	.010	.011	.013	.015	.016	.019	.022	.027	.035	.052
.2	.014	.017	.020	.022	.026	.029	.032	.038	.044	.055	.072	.110
.3	.021	.025	.029	.033	.038	.043	.049	.057	.067	.084	.113	.200
.4	.028	.032	.038	.044	.050	.056	.064	.075	.088	.110	.155	.270
.5	.035	.040	.045	.052	.060	.068	.078	.090	.110	.143	.200	.270
.6	.041	.046	.051	.059	.069	.080	.095	.110	.132	.167	.217	.224
.7	.047	.052	.058	.067	.079	.092	.105	.124	.150	.190	.215	.200
.8	.050	.056	.064	.072	.085	.097	.114	.133	.160	.184	.203	.175
.9	.053	.060	.069	.077	.090	.102	.123	.140	.162	.183	.190	.160
1.0	.057	.064	.072	.081	.094	.107	.125	.143	.160	.174	.177	.144
2.0	.060	.067	.074	.082	.090	.098	.106	.114	.120	.113	.094	.072
3.0	.049	.055	.060	.064	.068	.072	.076	.080	.079	.073	.064	.046
4.0	.040	.045	.049	.053	.056	.058	.060	.060	.059	.056	.049	.035
5.0	.033	.037	.039	.041	.044	.046	.048	.048	.047	.044	.040	.029
10.0	.017	.019	.021	.022	.023	.024	.024	.024	.023	.022	.019	.014

various values may be assigned to m and the equation in k solved by trial. By this method k was computed for different values of (a cos C) ÷s and of tan C. The values of k thus found were then modified so as to make sin C instead of tan C one of the arguments and are exhiibted in Table I.

For arches having a width of roadway not exceeding 60 per cent of the span and an obliquity not exceeding 60 degrees the eccentricity as shown in Table I is well expressed by the approximate formula

$$k=1/6.\ \frac{a.\cos C}{s}.\ \tan C=\frac{a.\sin C}{6s}.$$

Since the sine of the obliquity of the arch, B, is offset of abutments divided by the span (which is denoted by u), and the sine of the obliquity, of the development, C, is offset of abutments divided by the length of a longitudinal element (taken as equal to the length of the neutral axis and denoted by s), the angles B and C are connected by the equation u sin B=s sin C.

The width of the arch perpendicular to the roadway may be denoted by w= a cos B.

Hence the approximate formula for eccentricity may be put

$$k=\frac{a.\,u.\sin B}{6\,s^2}\ \text{or as}\ k=\frac{w.\,u.\tan B}{6\,s^2},$$

where a=length of abutment,
w=width of arch,
u=span on the skew,
s=length of arch rib along the neutral axis,
and B=obliquity of the arch (not the development).

Table II exhibits the relation between k and m.

For example, take an arch of obliquity B=15 degrees; span u=100 ft.; length of arch axis s=106 ft. (corresponding to a rise of about 15 per cent of span); width w=40 ft. Then sin B=.25882; cos B= .96593; sin C=u/s sin B=100/106×.25882 =.24417; C=14 deg. 8 min.; cos C= .96974; a=40/cos B=40/.96593=41.411 ft.; (a cos C)/s=(41.411×.96974)/106=.379.

Interpolating in Table I between 0.3 and 0.4 for (a cos C)/s and between 0 and 0.4 for sin C, gives k=0.016 for (a cos C)/s=0.379 and sin C=0.244.

TABLE II.

m	k	f(m)	m	k	f(m)
1.1	.0080	.0476	1	.0000	.0000
1.2	.0152	.0909	2	.0573	.3333
1.3	.0217	.1304	3	.0898	.5000
1.4	.0289	.1667	4	.1120	.6000
1.5	.0337	.2000	5	.1287	.6667
1.6	.0391	.2308	6	.1419	.7143
1.7	.0440	.2593	7	.1529	.7500
1.8	.0487	.2857	8	.1620	.7778
1.9	.0531	.3103	9	.1699	.8000
2.0	.0573	.3333	10	.1768	.8182
2.1	.0613	.3548	11	.1830	.8333
2.2	.0650	.3750	12	.1885	.8462
2.3	.0686	.3939	13	.1934	.8571
2.4	.0720	.4118	14	.1980	.8667
2.5	.0754	.4286	15	.2021	.8750
2.6	.0784	.4444	16	.2060	.8824
2.7	.0814	.4595	17	.2095	.8889
2.8	.0844	.4731	18	.2128	.8947
2.9	.0871	.4871	19	.2159	.9000
3.0	.0898	.5000	20	.2188	.9048
3.1	.0923	.5122	21	.2215	.9091
3.2	.0948	.5233			
3.3	.0972	.5349	30	.2405	.9355
3.4	.0996	.5454	40	.2546	.9512
3.5	.1018	.5555	50	.2648	.9608
3.6	.1039	.5652	60	.2727	.9672
3.7	.1060	.5745	70	.2791	.9718
3.8	.1080	.5833	80	.2845	.9753
3.9	.1100	.5918	90	.2890	.9780
4.0	.1120	.6000	100	.2930	.9802

m=Ratio of unit stress at obtuse corner to unit stress at acute corner; or ratio of length of arch from datum line to abutment at acute edge to length of arch from datum line to abutment at obtuse edge.
k=Eccentricity of resultant thrust.
f(m)=(m—1)/(m+1).

For this arch the approximate formula gives $k=(w.\ u.\ \tan B)/(6\ s^2)=(40\times100\times.26795)/(6\times106\times106)=.0159$.

From Table II, if k=.016, m=1.21 and the unit stress at the obtuse corner is 1.21 times the unit stress at the acute corner.

Measurement of the stress developed by models of skew arches made of 1/16-in. flexible packing and suspended as catenary hammocks confirmed, qualitatively, the theory of the foregoing analysis. In working with the models it was found to be extremely important that the skewbacks be parallel and in the relative longitudinal positions for which the arch was designed. Slight displacement of one skewback longitudinally toward the obtuse corner causes a relatively large increase in the eccentricity of the resultant thrust, and displacement toward the acute corner causes a corresponding decrease in eccentricity. If the obtuse corner is dropped below its proper level the eccentricity of the resultant thrust is decreased, and if the obtuse corner be raised above its proper level the eccentricity is increased.

RECOMMENDED PROCEDURE IN THE CONSTRUCTION OF GRANITE BLOCK PAVEMENTS

By Clarence D. Pollock, Mem. Am. Soc. C. E., Consulting Engineer, Park Row Bldg., New York, N. Y.

Great improvements have been made in granite block pavements during the last dozen years, both in better made blocks and the laying of the pavements.

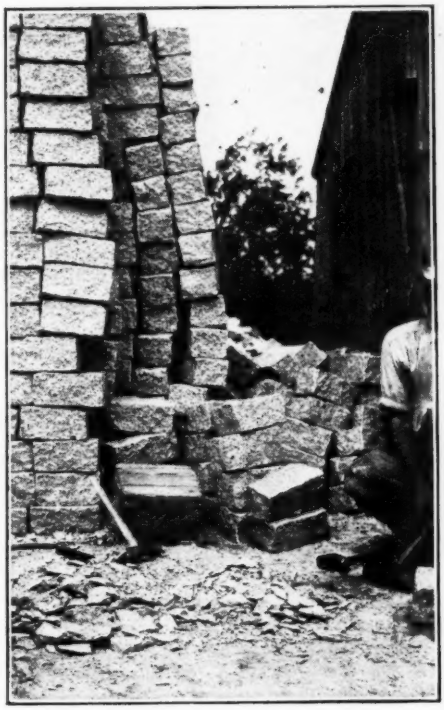
Standard Size Block

The adoption of the standard paving block, 3½ to 4½ in. in width, 4¾ to 5¼ in. in depth and 8 to 12 in. in length, so generally was a great step in advance. The block makers have become expert in cutting this block and make it very uniform both as to size and quality of dressing. This standard block has enabled the quarries to cut blocks ahead during dull seasons and thus accumulate a good stock so that prompt deliveries have resulted.

Concrete Foundation

In laying a modern granite block pavement a good concrete foundation 6 ins. in depth should be first constructed. This foundation should conform to the finished surface of the pavement and be parallel thereto.

Upon this concrete base a sand or a sand and cement cushion should be spread whose thickness should not exceed 1 in. and then the blocks should be carefully paved in straight courses at right angles to the length of the roadway except at intersections, where they should be placed so that the traffic will cross the long joints. The blocks should be well bedded in the cushion and paved with close end joints and the transverse joints should be as close as possible and yet keep the blocks in straight courses.



NEWLY MADE GRANITE PAVING BLOCKS.

After the laying of the blocks the pavement should be thoroughly rammed and all low blocks carefully lifted out with tongs in order that the adjacent blocks and cushion may not be disturbed, after which more cushion should be placed and these blocks replaced and rammed, after which the whole pavement should be thoroughly back-rammed to an even surface before the joint filler is permitted to be placed in the joints. The lack of proper ramming is one of the most fruitful sources of trouble with a granite block pavement.

The general custom is to sub-let the labor of paving at a square yard price. In this way the general contractor does not have such direct authority over the pavers as though he hired them directly,

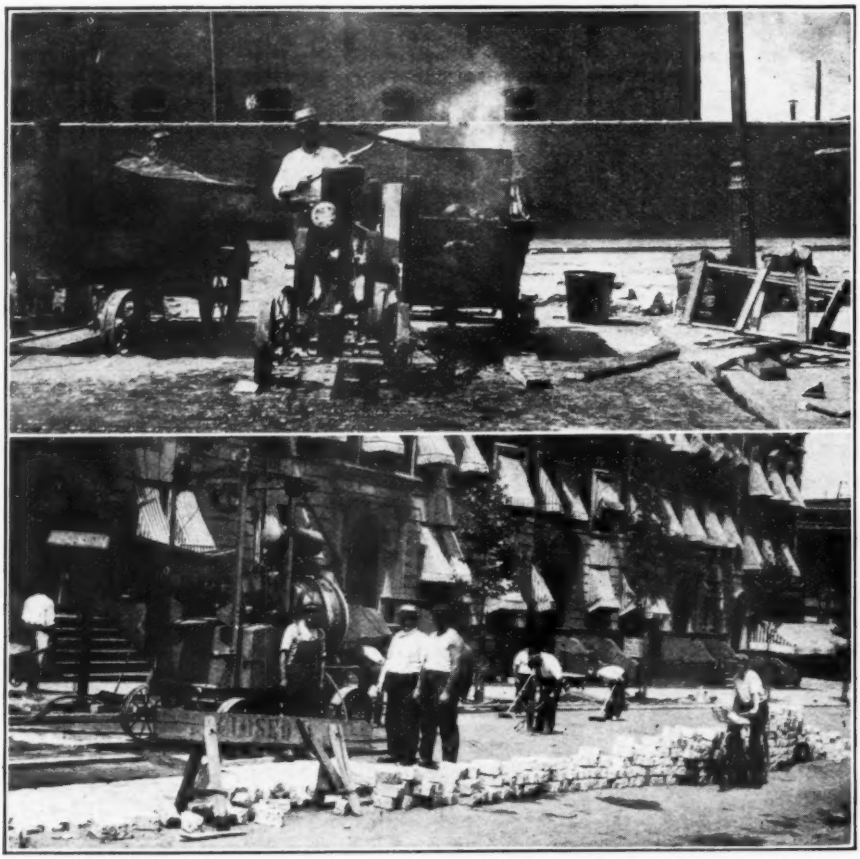
and as a result the sub-contractor will slight his ramming and save the wages of a rammersman whenever possible. The lack of ramming will soon show up after vehicular traffic is permitted to pass over the pavement. This matter of thorough ramming cannot be too strongly emphasized.

Asphalt Filler

The pavement is now ready for pouring the filler into the joints. The best practice is to fill the joints with hot asphalt mastic composed of asphalt and fine hot sand not to exceed 50% of sand. This mixture is flushed over the surface of the pavement and pushed into the joints by means of a squeegee. Care should be taken to get the joints thoroughly filled with the mixture while hot and leave as little of the filler over the surface as possible. After the joints are completely filled, and remain filled, a sprinkling of sand or grit should be scattered over the surface to prevent traffic from sticking to the filler left on the surface. Another good mixture is made of 5 parts of coal tar pitch with 1 part of asphalt which is mixed with fine sand and flushed into the joints in the same manner as previously described for the asphalt filler.

Cement Grout Filler

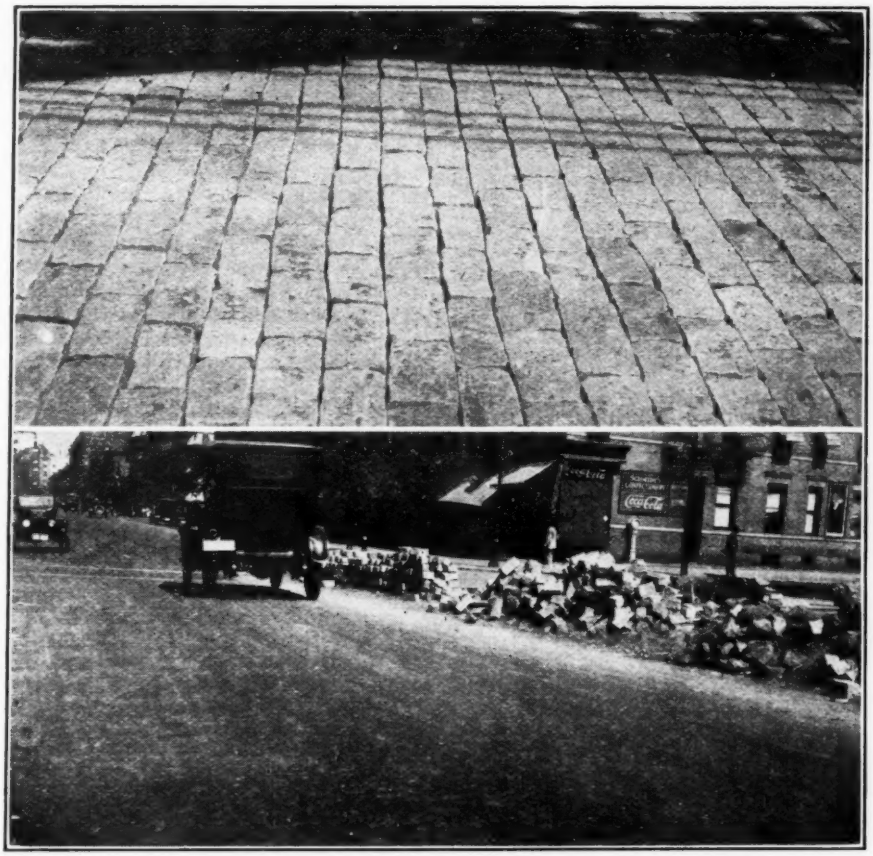
On streets which may be blocked off for sufficient time to allow a cement grout filler to obtain a proper set and where frequent openings are not likely to be made in the pavement, a cement grout filler of 1 part Portland cement to 1 part of fine sand mixed to the consistency of thin cream in a small batch concrete mixer, and flushed over the surface of the pavement until the joints are filled flush with the surface of the pavement is a very satisfactory filler and makes a first-class pavement. In the case where a cement grout filler is used if the traffic that passes over the pavement is heavy it is sometimes advisable to use a cement



ASPHALT MASTIC (TOP) AND CEMENT GROUT MIXERS USED ON GRANITE BLOCK PAVEMENT CONSTRUCTION.

and sand cushion on top of the concrete, mixed in the proportion of 1 part of Portland cement to 4 parts of sand, but in the case where a bituminous mastic filler is used the cement and sand cushion is usually a waste of money unless the traffic is kept off of the pavement until the mortar cushion has had sufficient time to set.

With both an asphalt mastic filler and a cement grout filler it is advisable to use a machine mixer and to deliver the filler directly from the machine onto the pavement in order that there shall be no chance for the sand to settle before the mixture is placed in the joints.



GRANITE BLOCK PAVEMENT READY FOR JOINT FILLER AND VIEW OF FINISHED PAVEMENT.

Selecting the Sand

In both cases it is also preferable to use a very even grained sand, as this remains in suspension much better than a graded sand. The best sand for this work is one of which at least 85% will pass a 20 mesh screen. The materials should be carefully measured and not guessed at. In the case of the mastic filler the amount of sand used will vary somewhat with the kind of asphalt and the sand used. It is well to try mixtures varying between 35% and 50% of sand in order to determine which works the best. With a good fine sand and a good asphalt in general about 40% sand usually works most satisfactorily.

As in the case of other kinds of pavements, it is necessary to give careful attention to details in order that the best results may be obtained. The asphalt must not be heated to a temperature that will possibly burn it and the sand must be thoroughly dried and not so hot that it will burn the asphalt when placed therein. When possible to obtain it the most satisfactory sand is obtained from asphalt plants heated in their drums and hauled to the street heated ready to mix with the asphalt.

Consistency of Cement Grout Filler

When cement grout filler is used great care should be exercised in regard to the proper consistency. The grout should flow readily and yet not be so thin that the water and cement separates from the sand. A mistake often made is that of ramming the pavement again after the first pouring of the grout. By doing this the initial set of the grout is likely to be broken and the filler will then crumble and cause loose or open joints. The ramming should be completed previous to the pouring of any grout. After the grout has obtained its initial set so that the covering of sand or loam will not stick or mix with it, such a covering of half an inch to an inch should be spread over the surface of the pavement and kept moist in hot, dry weather, in order that the grout may obtain a thorough set. No traffic should be allowed upon the pavement for at least 7 days, and preferably 10 days or 2 weeks.

Using a Shallow Block

In addition to the standard granite blocks as described above, some localities use a shallow 4-in. depth block. The advantage obtained by using this block is a saving in freight charges to inland cities having long rail hauls. Another block used to a considerable extent is known as the Durax block, which is a small, approximately cubical block, having faces from 3 ins. to 4 ins. square. These Durax blocks are usually laid in concentric arcs of circles, as in this way the joints are radial. The traffic crosses the joints diagonally and this obviates the disadvantage of the short breakage of joints due to using the small blocks. This method of laying the blocks gives an attractive appearance to the pavement, and with such small units a very uniform surface may be obtained. This pavement is usually laid in a dry mortar cushion of 1 part cement to 4 parts of sand placed upon the concrete foundation. The joint filler is usually asphalt mastic, and the traffic is blocked off until the mortar cushion has had proper chance to set. It has been found advisable to use a light roller upon this pavement previous to the pouring of the joints. The roller is helpful in obtaining a good surface when small units like the Durax blocks are used, but is not satisfactory with the larger blocks such as the standard blocks. In the latter case it is necessary to have the human element of the rammersman as the roller adjusts the high points of the blocks to a uniform surface, whereas in the case of the standard blocks it is necessary to adjust the general surface of the block to the general surface of the adjacent blocks rather than simply the high points.

Napped and Reclipped Block

Another form of granite block pavement is what is known as napped and reclipped block. The old style 7 to 8 in. depth granite blocks are napped or broken and two new heads are made by clipping the newly broken faces to rectangular heads. These blocks should be dressed to the same dimensions as the new standard granite blocks with the exception that the length will be less as the length of the new blocks will be the depth of the old ones. These should be laid in the same manner as the new blocks and with just as much care. There are many examples of napped block used without any recutting. In this case the longitudinal joints are poor because of the more or less rounded heads of the old blocks and soon become rough from traffic, causing ruts to form at these poor end joints. It is a mistake to use the old blocks unless they are cut to good rectangular shaped blocks. The old adage—whatever is worth doing is worth doing well—most certainly applies here.

SUGGESTIONS ON SUBDIVISION PLANNING

By S. G. Swigart, of Swigart & Ehrman, Civil and Hydraulic Engineers, 1118 Second National Bldg., Akron, Ohio.

The subject of subdivision planning has not been given the attention it merits in most of our technical journals. Several books on City Planning have been written, but the subject has seldom been mentioned in any of the engineering journals. The older portions of most of our Eastern cities, especially, and some in the Middle-west were laid out without any definite plan, in fact they "just grew." As the population increased and land became too valuable for agriculture each owner would subdivide a tract of land, quite often irregular in shape, according to his own notions and generally to get the largest number of lots out of it without any regard to adjacent unplatted land at all and often with very little regard to existing streets, drainage and public convenience. The result is a jumbled up system of streets, expensive grading and sewerage and a generally bad appearance. Within the past few years public sentiment has demanded and secured legislation providing for Planning Commissions

and a City Planning Engineer with power to enforce certain regulations regarding the laying out of new subdivisions so that in the future they should be laid out with reference to the public convenience.

Planning Commission and Its Powers.

The Planning Commission should have authority to enforce reasonable regulations within a distance of three or four miles from the city limits and should be composed of practical business men who are posted in a general way on the subject of City Planning and they should employ a thoroughly capable Civil Engineer who is especially qualified for the work. They should require: (1) A preliminary plat showing contours, proposed layout, and adjacent lands and streets. This to be approved or altered according to decision of the Planning Commission. (2) A final plat for record, showing all dimensions, angles, curve data as radii on both center and side lines of streets, central angles, tangent distances, long chords and arcs for total lengths of curves and for each lot, location of all monuments, block distances on street center lines and side and locating building lines. (3) Profiles of all streets on center lines and both side lines and in addition on building lines on both sides. (The above are all necessary for intelligently establishing grades.) Suggested grade lines should be shown on these profiles in pencil, subject to approval or alteration by the City Engineering Department, and (4) Complete plans for sewers and water mains.

Plan.

The plan should take into consideration surface drainage and sewerage, views from building sites, conections with existing streets, traffic circulation especially to important traffic centers, and proper zoning. A point generally ignored is that on residence lots no more than one residence should ever be permitted on any one lot and no lot or lots should ever be resubdivided. This would protect adjoining property owners as to the class of residences and from damage to property values by future owners cutting the original lots into very small lots and building a large number of houses on a small area. Zoning is very important also for the protection of property values and proper and intelligible location of business centers and manufacturing sites and for classification of residence districts according to values, etc. This, of course, is a sufficiently large subject in itself for a good-sized book, but a few suggestions here will probably not be amiss. Small business centers should be located at convenient sites in residence districts and proper restrictions required. The location of such business centers should, of course, be at and near the intersections of the most important streets. These should be limited to groceries, meat markets, drug stores and such small businesses as are needed for serving the adjacent residence districts. The classification of residence districts is also a very important matter for the protection of property values and for the beautifying of the city.

Where restrictions are made in the deeds as to values, etc., this matter is automatically taken care of but the Planning Commission should have authority to regulate such restrictions as individual subdividers may have very different notions and one subdivider may lay out small lots and allow cheap residences immediately adjacent to another very high-class subdivision.

Widths of Streets

Streets should vary in width according to size of lots, class of residences and amount and character of traffic. This is a subject upon which opinions differ widely and I will simply state my own views. There are, in the United States, extremes both ways. We find very wide streets in some of our cities, especially in the West where much narrower ones would not only suffice to take care of traffic, but would be much less expensive to improve and maintain and, on the other hand, we find many streets in our Eastern cities, which are totally inadequate to take care of traffic. The principal business streets of a city, also the main driving thoroughfares and boulevards, should have a width of from 80 ft. to 130 ft., and possibly in some cases 150 ft. The principal residence streets should be from 60 ft. to 100 ft. wide and the minor residence streets, where there is no through traffic should be from 40 ft. to 50 ft. wide. I know that many engineers believe in a minimum street width of 50 ft., but I know of many 40 ft. streets which appear to me ample to take care of all the traffic which will ever come over them. This is especially true of short streets where there is practically no traffic except by the immediate residents, their friends and delivery cars. To require a wider street in such cases places an extra cost for paving and maintenance which seems to me entirely unjustifiable.

As to the proper division of these vari-

ous widths into pavement, lawn and sidewalks, this varies somewhat again according to character of street, amount of traffic, and on residence streets, classification, depth to building lines and whether there are street car tracks. On business streets, with a very heavy traffic, of course, no lawn spaces are required and the total width is taken up by the pavement (including car tracks) and the sidewalks. In such streets the following table gives about the proper width of pavement and sidewalks on each side:

Total Width	Pavement	Sidewalks Including Curb
150 ft.	100 ft.	25 ft.
140 ft.	96 ft.	22 ft.
130 ft.	90 ft.	20 ft.
120 ft.	80 ft.	20 ft.
110 ft.	76 ft.	17 ft.
100 ft.	72 ft.	14 ft.
90 ft.	68 ft.	11 ft.
80 ft.	60 ft.	10 ft.
70 ft.	50 ft.	10 ft.
60 ft.	44 ft.	8 ft.

For residence streets the following table gives the appropriate subdivision of width for pavement, two sidewalks and two lawn strips. Of course, it is not claimed that these will suit all cases, but in general they are as near correct as possible:

Total Width	Pavement	Lawn Including Curb	Sidewalk Each Side
100 ft.	60 ft.	10 to 12 ft.	8 to 10 ft.
90 ft.	56 ft.	9 to 11 ft.	6 to 8 ft.
80 ft.	50 ft.	8 ft.	7 ft.
70 ft.	40 ft.	8 ft.	7 ft.
60 ft.	34 ft.	7 ft.	6 ft.
50 ft.	28 ft.	5 ft.	6 ft.
45 ft.	24 ft.	5.5 ft.	5 ft.
40 ft.	22 ft.	4 ft.	5 ft.

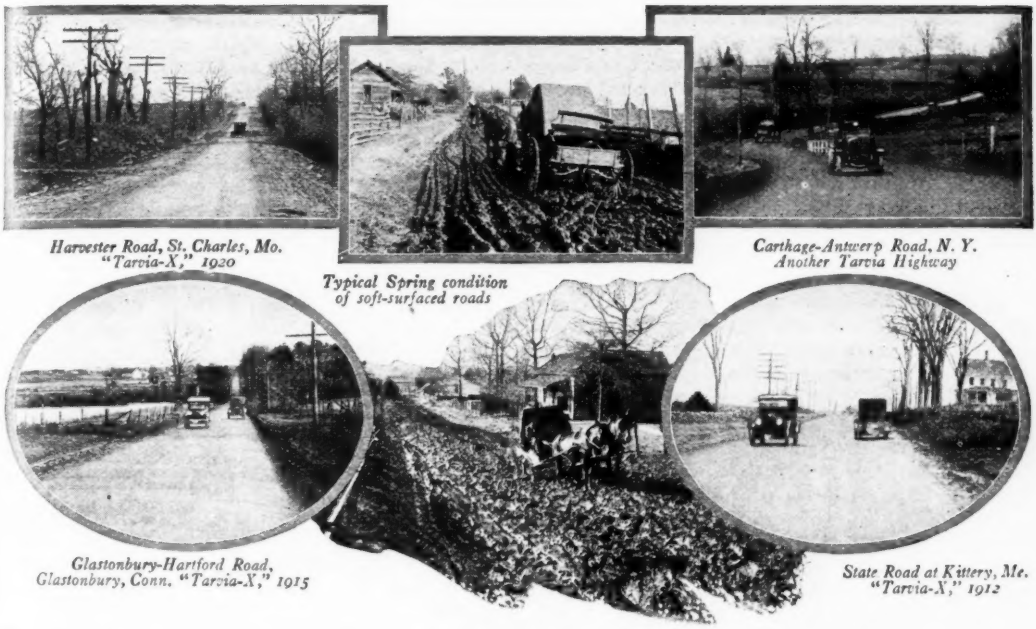
In cases of boulevards and parkways every case is governed by special design. Where there are street car tracks, the pavement should always be wide enough for ample clearance for vehicles on both sides. The crown of the street should vary as the width, sloping on a true plane from the center to both curbs at a rate of from ¼ in. per foot for asphalt or equally smooth pavements to ½ in. per foot for stone pavements, except in narrow streets, where it may slope as much as ¾ in. per foot with stone pavements. On grades over 2 per cent, these slopes should be reduced. Some engineers prefer a curved cross-section in which case the crown at the center should be the same and a circular curve used to fit, the crown being the middle ordinate. The objection to curved crowns is that they are too flat near the center for drainage and too steep near the edges for safe driving. The curb should generally be level with the crown and the lawn should slope ¾ in. per foot and the sidewalks ¼ in. per foot.

Landscape Design for Subdivision.

It is quite common at present for high-class subdivisions to be designed by landscape architects or at least designed with mostly curved streets by an engineer or by a landscape architect co-operating with an engineer. The practice became almost too common in our city during the boom of 1919-20. In many cases, in my opinion, curved streets were laid out where they do not fit the topography and where straight streets really would be better. I do not believe in introducing curves in streets without any good reason from a topographical standpoint. The only good reasons for curves are improvement of view from the street itself and from residences, reducing of grades and improving the scenic effect. One or the other of these reasons is always given as the reason for curves, but in many cases it is pretty difficult to see the point. It should be taken into consideration that curves shorten the view for automobile drivers, increase the danger of skidding when pavements are wet and consequently require slower driving for safety than straight streets. For these reasons they should be avoided on streets where the traffic is likely to be heavy. They should also be avoided in business sections entirely, except at necessary turns or corners and then they should be short. There is no doubt that for parks or private grounds curved parkways and drives are entirely appropriate, but except for the reason given above it is my opinion that they should be carefully avoided. On rolling ground there is sufficient reason to introduce enough curvature to satisfy every requirement of beauty, etc., without locating them where there is no good reason. Where curved streets are laid out, as a general rule, the side lines of the lots should be radial and the buildings should be required to be set so that the front line is a chord of a curve concentric to the street on the building line.

Maximum and Minimum Grades.

Grades for streets should be limited, but not according to any fixed rule. What would seem like a very light grade in some localities would seem excessive in other places. Also what might be too heavy a grade for a through street with heavy traffic might be entirely reasonable for a short street with only local traffic. However, the following may be considered as reasonable limits for grades: For business streets or through traffic streets where all classes of traffic are common



Harvester Road, St. Charles, Mo. "Tarvia-X," 1920

Typical Spring condition of soft-surfaced roads

Carthage-Antwerp Road, N. Y. Another Tarvia Highway

Glastonbury-Hartford Road, Glastonbury, Conn. "Tarvia-X," 1915

State Road at Kittery, Me. "Tarvia-X," 1912

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the grade should not exceed 7 per cent in any case and where practicable the limit should be 5 per cent. For short residence streets where there is only local traffic the maximum limit might be as high as 13 per cent. Of course, on steep grades, smooth pavements should not be used. The minimum limit depends on the kind of surface and should vary from 0.3 per cent to 0.5 per cent.

It is my opinion that it would be wise for planning commissions to require on all new subdivisions that the real estate developer should install all public improvements within a certain specified time and pay the entire cost with no expense to the city. Of course, this would stop many of the subdivisions from being laid out, but it would lead to much more conservative development. It would not interfere with the development of subdivisions in desirable locations or where there is a real demand for them and it would tend to discourage wild-cat speculation and the subdividing of land that should be kept for farming purposes for years to come. Of course, it is not necessary to require as high-class improvements on the cheaper grade of allotments intended for industrial employes' residences, but at least such improvements as street grading, sidewalks, sewers, water pipes and street lighting should be required on these.

It seems almost unnecessary to say that subdivision work, in all its phases, is strictly a civil engineer's job and should be entrusted to competent civil engineers only and yet there are many of our subdividers who entrust such work to men who would be unable to qualify as rodmen with first-class engineering organizations. While experience generally teaches them the folly of this it is almost always after a great deal of damage has been done and sometimes after the work has reached such a stage as to make it practically impossible to remedy it. I have often said that poor engineering and surveying work is not only not worth anything, but is an actual damage.

PRESERVING SAND-CLAY, GRAVEL AND TOP SOIL ROADS IN NORTH CAROLINA

In the consideration of the problem of how to preserve and derive the maximum service from its top soil, sand-clay and gravel roads, the State of North Carolina has something in common with many other States, having large mileages of these types of roads which now demand some form of treatment to protect them from the disintegrating effects of modern traffic and the elements.

It is generally recognized that the best results are to be obtained through the application of a bituminous material. However, many states and counties have encountered the same difficulty experienced by the North Carolina State Highway Department. This Department has found that a material light enough to penetrate the sand-clay, top soil or gravel surface does not have binding quality, and on the other hand it was developed that a material which did have sufficient binding quality was too heavy to penetrate the road. In the case of the heavy treatment, the bituminous material went into the formation of a mat on the surface of the road, and the bond between the road and the bituminous mat was eventually destroyed by the dusting up of the surface beneath the mat. The weakness in this treatment was not in the bituminous blanket but in the contact between the bituminous blanket and the road surface.

Undoubtedly this has been the experience of many of the other states having large mileages of these types of roads, and the experiment being conducted by North Carolina will be of interest and value.

The sand-clay, top soil or gravel surface is first softened by sprinkling, and then a single layer of broken stone or gravel of approximately 1½ ins. in size is rolled into the surface. After giving the surface time to dry out, and in order to secure maximum consolidation, the roadway is opened to traffic for a short period, after which it is swept clean by brooming.

The road then presents an ideal surface for treatment with an asphaltic material, one to which a material possessing the desirable binding qualities may be applied without danger of being separated from the road surface by the dusting up of the surface as a result of the impact of traffic.

The North Carolina State Highway Department has been using Texaco No. 55 Road Oil in its experiments, and while the new construction has not been subjected to traffic long enough to say that it has proven absolutely satisfactory, it is anticipated that the result of the experiment will be to produce a waterproof, durable and resilient mat which will add considerably to the efficiency and life of sand-clay, top soil and gravel roads.

WATER WORKS SECTION

MOTOR DRIVEN CENTRIFUGALS WITH GAS ENGINE STANDBY

By W. B. Bushnell, Supervising Engineer, Champaign & Urbana Water Co., 18 Taylor St., Champaign, Ill.

Prior to 1917, the Champaign and Urbana Water Company generated all the power required for the operation of its pumping equipment.

During this year, however, it entered into a contract with the Urbana and Champaign Railway, Gas and Electric Company to purchase all the electric power it required from them. This decision was reached principally because of the following conditions:

1. The power company offered to enter into a contract to furnish electric power at rates which very closely approximated the cost at which the water company was producing it.
2. The signs of the times indicated that the future source of cheap power was likely to be from large generating stations which transmitted and distributed the power over extensive territories.
3. The water company would in a comparatively short time be compelled to install additional electrical generating equipment in order to meet its demands.

A contract was entered into and a connection was made to the Urbana and Champaign Railway, Gas and Electric Company power plant. About the same time another connection was made to the power plant of the Urbana Light, Heat and Power Company. This latter connection is used only in case of failure of the supply from the former company.

The water company continued to maintain as a standby unit one 2,500,000 gals. per day Laidlaw-Dunn-Gordon steam service pump. It also maintained in service as standby equipment a 200 KVA generating unit which was of sufficient capacity to generate the power necessary for the operation of its well pumps. These gave an additional assurance of the continuity of water service. The service was maintained in this manner until 1921 when the demand on the water company's plant became sufficient to require the installation of additional service pumps.

It was necessary, at this time, to put into operation all of the motor-driven pumps in order to furnish adequate fire pressure. The regular domestic service was then supplied by two 1½ MGD centrifugal pumps which could be operated either in parallel or in series. During a certain portion of the day both these pumps were required to furnish domestic service. It was therefore decided that any additional units should be of 3 MGD capacity.

This company had had quite a lengthy experience with reciprocating steam pumps and about seven years' experience with motor driven centrifugals. In the light of its experience it was an easy matter to decide that any additional pumping equipment should be of the centrifugal type.

By this time the demand had reached a point at which the Laidlaw-Dunn-Gordon steam pump was inadequate to carry the load in case of total failure of the supply of purchased power. It was, therefore, decided that additional standby equipment should also be supplied.

The Equipment.

To meet the combined need of equipment for normal operations and for standby service, two centrifugal pumping units were installed, each consisting of:

One 8-in. single stage, double suction DeLaval centrifugal pump connected at one end through special jaw coupling to one 145 H. P. model FC-6 Sterling gasoline engine, and at the other end through a flexible coupling to a type KT-General Electric, 3-phase, 60-cycle, 220-volt squirrel cage motor with starting compensator.

The pumps were designed to deliver 2,100 g. p. m., against 127 ft. total head, having a guaranteed efficiency of 78 per cent at speed of 1,160 r. p. m., and to permit of operation either in parallel or in series. When the pumps are driven by the gasoline engine the motor rotors are allowed to float.

On March 22, 1921, when the two units were put into operation there became available for stand-by service a total domestic service capacity of 8½ m. g. d., or a total fire service pumping capacity of 5½ m. g. d. The 200 KVA generator was continued in operation so that the

plant was in a position to maintain continuous service under extremely adverse circumstances.

Installation Features.

Some interesting features in connection with the installation and operation of these units will be briefly given below.

The pumps were set at right angles to each other, a position necessitated by the available floor space, and it is of interest to note that had the same pumping capacity been provided by means of steam pumps an addition to the pumping station building would have been necessary.

These pumping units have a common suction line which is 18 ins. in diameter and 180 ft. in length to the point at which the nearest pump obtained its supply. The pumps may be thrown in parallel or in series by means of hydraulic valves. The small valves which control both hydraulic valves are in one place so that their joint operation is quite easily accomplished.

There was quite a little difficulty experienced in setting these pumps which might have been eliminated had there been one or two flexible connections in the pipe lines instead of being all of rigid flange connections.

The gasoline supply for the engines is stored in two tanks of about 60 gals. each, buried in the ground outside the building. The gasoline is forced to the engines by means of air pressure created by an air pump which operates to fill a storage tank which may be made to feed into the gasoline tanks. The gasoline piping is so arranged that either one of the tanks may be drawn from and it is the practice to keep one cut out at all times so that should the engine stop from lack of gasoline a full tank will be available and warning given that the other tank should be filled. The combined capacity of the two tanks is sufficient to operate both engines at full load for about five hours. A Standard Oil station is within two blocks of the plant and arrangements have been made with the attendant whereby it is possible, in case of necessity, to obtain gasoline at any time of day or night. For this reason it is deemed sufficient to carry a maximum supply sufficient for five hours' run under fire service conditions.

The exhaust from the engines is carried outside of the pumping station building and there passes through Maxim silencers, which very efficiently perform the duty for which they were designed. In fact, the noise from the exhaust is barely audible for a distance of a couple of hundred feet. This is somewhat in contrast with the noise of the running engines within the building which is especially noticeable because of the quiet operation of the motor driven centrifugal pumps. However, this is not an especially objectionable feature for stand-by equipment, due to the comparatively short duration of time that they are called into service.

The gasoline engines are equipped with self-starters and generators for charging the storage batteries required for same. The generator is regularly installed from the shaft geared to the main shaft of the engine. This arrangement would, no doubt, be quite satisfactory for an engine which did not start often and then ran for quite a period of time. These engines, however, are started twice a day and run only a few minutes at low speed for testing. Under these conditions it was found that the batteries were not maintained in a charged condition. For this reason the generators were placed so that they might be operated by the shaft on the motor side of the pump. In this manner the charging may be continued during the normal operation of the pumps.

There has been but one occasion upon which these engines have refused to start and this could be traced to the use of a poor grade of oil. Upon investigation at this time it was found that the spark plugs were so badly carboned that it was surprising that the engines had not refused to start long before. The trouble was eliminated by using a different grade of oil.

Some investigation has been made of the storage batteries. It was found some time ago that they had reached a point where all the cells could not be charged as they should. The results of the investigation were that the starting current for the first second or two was 130 amps. and then dropped to 80 amps. As these batteries are of 50 amp.-hr. capacity it will be seen that under the nature of service they are required to perform, they are called upon to stand quite a little abuse. Batteries of sufficient size to perform this service without being abusive would necessarily be quite large and cost a considerable sum. It was, therefore, concluded that it would be better to use batteries of the present size as long as they would perform the work required of them and then buy new ones about the same size.

The normal pumpage during the greater part of the day is taken care of by one of these pumps. When it is necessary to

furnish fire pressure these two pumps are thrown in series as well as other pumps. In the process of throwing these pumps in series, at a time when the water in the reservoir is below the pump suction, it is possible to manipulate the control valves so that one pump will lose its suction. This can be prevented by proper opening and closing the valves in proper order, but we found upon one or two occasions the valves were not properly operated. In order to provide a quick remedy for human error in this regard a No. 0 Nash vacuum pump was installed so that it is driven from pulley in the shaft of the pump. By means of this the prime can be regained in somewhat less than a minute.

From the experience of operating these units for the past year we are of the opinion that the gasoline engines provide a very satisfactory method of providing stand-by power.

The foregoing paper by Mr. Bushnell was presented at the recent annual meeting of the Illinois Section of the American Water Works Association.

THE CONSTRUCTION OF THE LOCH RAVEN DAM OF THE BALTIMORE WATER WORKS

By Wm. A. Megraw, Water Engineer, City Hall, Baltimore, Md.

Baltimore is engaged in making what is known as the Gunpowder improvement to its water supply. The plans include a dam at Loch Raven on the Gunpowder river to impound 23 billion gallons of water, and a balancing reservoir to limit the pressure on a 7-mile tunnel conducting water to the city, together with the necessary relocation of roads and bridges, the purchase and removal of the villages of Warren and Phoenix, the relocation of 1.5 miles of Pennsylvania Railroad tracks near Phoenix, the purchase of about 4,000 acres of land from 54 different owners and clearing the ground to be flooded of buildings, trees and vegetable matter.

The principal feature is the Loch Raven Dam, which is nearing completion. Plans were first prepared in 1913 and the work completed during the following year to elevation 188 ft. above mean tide, the base being made broad enough to support the additional section necessary for raising the dam later to elevation 270. The plans, under which the present contract is proceeding, provide to raise the dam from elevation 188 to elevation 240. The dam is a solid concrete structure, 640 ft. long over all. The spillway is 288 ft. long and raises about 103 ft. above bed rock.

Allowing for Upward Pressure

In designing the cross section, upward pressure was assumed on all horizontal joints, equal to the full hydrostatic pressure at the upstream face, decreasing to zero at the downstream face. Porous drains in the horizontal joints, which will be described later are provided to relieve upward pressure. Two 48 in. pipes passing through the old foundations control the ordinary flow of the river and enabled all concrete to be deposited on dry surfaces. One in. bent steel rods, 5 ft. apart horizontally and vertically, imbedded 3 ins. back of the down-stream face, can be straightened to assist in binding the new concrete to the old, in case the dam is ever raised to a higher elevation.

The gate chamber is divided into two separate compartments and each is designed to supply the city separately. Fifteen sluice gates, 3½ ft. by 6 ft., arranged at different heights, control the entrance of water.

Transportation Arrangements

The dam is located between steep hillsides and the available working space is small. Stone was furnished from a city quarry located on the west side of the river 3,000 ft. down stream from the dam. An improved highway extends from a point on the hillside opposite and above the dam down to and past the quarry to Loch Raven Station on the Maryland and Pennsylvania Railroad about 2,200 ft. farther down. Loch Raven Station is about 11 miles from Baltimore. The railroad at Loch Raven Station is approximately at right angles to the river and follows along a steep hillside about 50 ft. above the highway, which turns and parallels the railroad in both directions. A siding about 1,600 ft. west of the railroad station provides a means of handling materials from the railroad by gravity to the highway below. An old city-owned siding 1.6 miles long is located on the west side of the river and extends from the dam southerly to a point where the railroad, 1.2 miles east of Loch Raven Station, meets it at grade. This arrangement of highways, railroads and sidings, offered several means of handling the work of construction.

The contract was awarded to the Whiting-Turner Construction Company of Baltimore on April 6, 1921, and about July 1 the first concrete was deposited. The bulk of the work was completed by January 1, 1922.

Chuting System

The specifications permitted the use of cyclopean concrete, but the contractor installed a chute system for distribution, which precluded the depositing of large stones, except in the east shore section, where a derrick, used for excavating the east abutment, swung a portion of the larger stones into the dam. The chute system was designed by the Lakewood Engineering Company.

On the west of the river, the topographical conditions were ideal for a gravity plant. The contractor, availing himself of this advantage, located his crusher, storage bins and mixing and distributing plant up and down the west hillside just south of the site for the dam, although the city siding on the opposite side of the river connected the dam directly with the main line of a railroad.

Handling Cement

Cement was the only material hauled by railroad. On the hillside below the siding at Loch Raven Station, a cement house was built with a capacity of 5,000 bbls. The cement was here received in bags and handled by a belt conveyor operated by a gasoline engine which also operated a bag shaker consisting of a wire cage rotating about 7 minutes for each charge. By means of a chute the bags of cement were passed to trucks. The trucks transported the cement to a 200 bbl. capacity shed located on the hillside above the plant, whence it was conveyed directly to the mixer platform by chutes.

Working Sand Pit

The neighborhood sand is generally not suitable for concrete, but the contractor was able to locate an excellent sand pit about 2 miles from the dam. The cost of sand at the pit was 24 cts. per cu. yd. and the cost of trucking 44 cts. per cu. yd., making a total of 68 cts. for the sand delivered. The quotation for river sand shipped from Baltimore was 70 cts. per ton plus $1.14 for freight, which is the equivalent of $1.45 per cu. yd. The contractor was thus saved 75 cts. per yard and the delays consequent to rail shipment.

The sand was excavated by a ¾ yd. revolving steam shovel and transported by motor trucks to a point above the plant and dumped directly into a hopper at the elevation of the highway, from which a belt conveyor carried it to two large storage bins, one of which is located on each side of the stone bin. The total capacity of the two bins is 500 cu. yds.

The sand contained a maximum of 10% of clay which was twice the amount authorized by the specifications. It was accepted only after thorough tests were made. One to three mortar briquettes showed an average of 250 lbs. per sq. in., which is 50 lbs. above the standard requirement. At different times, as the work progressed, 4 in. cubes were made from concrete as it passed from the chutes into the dam. The compressive strength of these cubes at the end of 28 days averaged 1,800 lbs. for 1-3-6 concrete and 2,220 lbs. for 1-2-4 concrete. The sand was well graded from small to large and contained a considerable percentage of gravel for which reduction was made in the stone. The clay seemed to lubricate the concrete, causing it to be more easily mixed, chuted and worked. The concrete produced a smaller amount of laittance than is usual and honeycombing is almost entirely absent from the dam.

Quarrying Stone

The stone was taken from the city quarry with no expense other than that of actual quarrying. For each blast, two large well drillers were used to put down about 10 holes 12 ft. apart and 85 ft. deep, located parallel to and 20 ft. back of the quarry face. Three large blasts, each requiring about 4,200 lbs. of dynamite, made at different times as the work progressed, were required to throw down the necessary 45,000 yds. of rock. After each shot considerable secondary drilling was done by various kinds of drills, and tripod and jackhammer, besides a large amount of mud capping, in order to reduce the stone to steam shovel size. The air used by the drills was piped from the power plant located below the dam. A ¾ yd. Erie shovel used at the beginning of the job soon proved insufficient and was replaced by a 90 ton Marion shovel for loading the stone into dump cars.

Crushing Stone

The cars were hauling a half mile to the dam over a 36 in. gauge track by an 18 ton dinkey, 4 cars constituting a train. As the track approached the dam, it was elevated on a trestle at 5.8% grade and dumped directly into a 1,500 ton gyratory crusher. A hoisting engine was used to spot the cars up the incline to the front of the crusher, which enabled the locomotive to return for another train while the first trainload was dumped and crushed. From the crusher the broken stone was raised to an overhead bin by means of a belt conveyor. The stone bin has a capacity of 1,000 cu. yds. and is located between the two sand bins.

Mixing Concrete

Water for the concrete is taken from

the river above the dam and measured by two barrels pivoted on their centers and so placed that each will empty into a mixer by hand. Each barrel has a 2½ in. quick opening valve and a mark on the inside to indicate the quantity of water desired.

The sand and stone bins each discharge through a separate chute to a hopper located over a concrete mixer, the hopper being calibrated to measure the quantity of sand and stone required for one batch of concrete and designed to dump all material simultaneously into the mixers. Two 1-yd. mixers have been used: a Smith tilting mixer and a Ransome non-tilting mixer. For work of this character, it developed that the Smith tilting mixer gave better results than the Ransome non-tilting mixer.

The concrete is elevated from the mixers by buckets operating inside of a double wooden tower 204 ft. high and distributed by chutes to the desired points. The concrete buckets are raised by engines, one for each bucket, located at the elevation of the highway about 75 ft. above the bottom of the lower pit.

Expansion Joints

The dam is built in 60 ft. lengths, seperated by transverse expansion joints extending continuously through the cross sections; 5/16 in. by 12 in. vertical steel plates, placed 18 ins. back of the up-stream face, are intended to seal the expansion joints. The up-stream face of the dam is composed of 1-2-4 concrete placed in 8 ft. lifts alternately 6 ft. and 7 ft. back from the face. The remainder of the section is composed of 1-3-6 concrete. The following concreting proccdure generally was followed:

Placing Concrete

First, a lift of 1-2-4 concrete, 60 ft. long between expansion joints was deposited. After twelve hours, the forms were removed and 1-3-6 concrete was then deposited in one operation from the back of the 1-2-4 concrete to the down-stream face and for a full length between expansion joints. The 1-3-6 concrete was generally brought 1 ft. higher than the 1-2-4 concrete. The two grades of concrete thus break joints both horizontally and vertically and the only vertical joints, except the expansion joints, are those between the two grades of concrete.

Six inch by 12 in. horizontal bonding grooves, 2 ft. back of the front face and a 14 in. by 14 in. porous block drain 2 ft. further back from the face were placed in the 1-2-4 concrete at the completion of each lift. The bonding groove and groove for the tile drain were cut out by hand as soon as the concrete had sufficiently hardened. The ends of the tile drain are covered with burlap dipped in tar, and the space between the tile and groove filled with dry sand. At each expansion joint, the porous drain enters a 3x3 ft. well, extending vertically upward and downward to galleries respectively above and below the highest and lowest horizontal joints, by means of which inspection can be made of the seepage through the dam. The lower gallery is drained into the tail water on the downstream side. Vertical bonding grooves 2 ft. wide by 7 ft. deep and 10 ft. apart, bond the masonry across the expansion joints.

Supporting Forms

The 1-2-4 concrete originally specified for the downstream face was omitted and 1-3-6, deposited as described above, was substituted. The placing of forms on the downstream face presented a problem. There was no way of supporting them from the interior without leaving considerable timber in the concrete, and supporting them from the outside would have been expensive. The problem was solved by wiring the forms to dowels inserted in the existing concrete. A few props held the forms in place ready for pouring. As the concrete was deposited, the pressure soon became sufficient to keep the forms from collapsing, and the props were then removed. It was necessary to drill holes in the old foundation concrete, for the dowels, but above that elevation, at the end of each day's pour, as soon as the concrete had set sufficiently, pieces of scrap pipe were put in place to serve as dowels.

Installing Gate Valves

In the gate chamber one 24x24 in. and eleven 6-ft.x3.5-ft. gates were placed. The specifications provided that all gates be securely blocked and fastened in position before concreting. The gates will be operated by stems varying in length from 50 ft. to 75 ft. and were required to be set exactly plumb; but as each gate weighs 4,700 lbs., it was practically impossible, with the means available, to sustain them in place while concreting around them. In construction, therefore, the bolts for the gate frames were set as the concrete was deposited and the gates and gate frames were set after concreting of the gate chamber was completed.

The rock stratification on the east hillside is so much inclined from the horizontal that it was impossible to expose a large face without causing a rock slide. It was possible, however, by stepping the

foundation to keep a rugged wall of rock against which to place concrete. About 2,000 yds. of solid rock was estimated, but owing to the sliding tendency, over 5,000 yds. were excavated. Excavation for the east abutment was started before completion of the construction plant, yet, due to the difficulties encountered, this portion of the dam was the last completed.

In order to convey concrete from the mixers on the west side of the river to the easterly part of the east abutment, the concrete was rehandled at the east tower. An elevator bucket within the tower was filled from the line chute, then elevated, and the contents emptied into a second chute higher on the tower. The east tower is 168 ft. high and the west tower 204 ft. high. The towers are 340 ft. apart and connected by a 1½ in. cable which carries the concreting chute.

Causes of Time Losses

The capacity of the plant is about 600 cu. yds. of concrete per 10 hour day, although at times 700 cu. yds. have been placed in the same time. The average per working day was 300 cu. yds. A considerable portion of the contractor's plant had been used before, but the loss due to breakdowns was not excessive. The records of the resident engineer show a loss of 483 working hours. Of this time 48% was due to breakdowns and other troubles with the mixers, 22% due to changing and clogging of chutes, 14% due to accidents in the towers and 15% due to lack of forming space and other causes. On the whole the work progressed with rapidity, which was due in part to the hearty co-operation between the contractor and the engineers.

The Contractor's Equipment

1—Marion 31 revolving steam shovel.
1—Erie type "B" revolving shovel.
1—Marion 61, railroad type, steam shovel gasoline pumping outfit.
1—18-ton Vulcan narrow gauge dinkey.
1—14-ton American narrow gauge dinkey.
10—Koppel 4-yd. dump cars.
10—Western wheel scraper 4-yd. dump cars.
1—325-cu. ft. Ingersoll-Rand steam driven air compressors.
1—160-cu. ft. Chicago Pneumatic Tool air compressor.
1—Bull Dog 20-in. gyratory crusher—rated capacity, 1,500 tons 10 hrs.
1—175-h.p. horizontal Corliss valve steam engine, driving crusher.
1—24-in. rock bucket elevator.
2—20-in. belt conveyors—1 driven by 12-h.p. vertical steam engine, and 1 by 12-h.p. Otto gasoline engine.
1—Link belt sand washer.
1—Steam driven duplex pump, 6-in. suction, 5-in. discharge, for general water supply.
2—Duplex boiler feed pumps.
1—15,000-gal. wooden tank for water supply.
1—150-h.p. locomotive type boiler.
1—150-h.p. Scotch marine boiler.
1—60-h.p. vertical boiler.
1—30-h.p. vertical boiler.
1—Ingersoll-Rand drill sharpener, air operated.
1—Circular saw.
1—Band saw.
1—Grinder.
1—Power-operated pipe-threading machine.
1—Contractor's equipment 7½x10 double drum hoisting engine with boiler.
1—3-drum, 8x12 Munday hoist with boiler.
1—8¼x10 double drum Lidgerwood hoist with boiler.
1—8x10 Lidgerwood hoist with boiler.
1—5x8 double drum hoist with boiler.
1—7x10 American double drum hoist with boiler and boom swinger.
1—8½x10 double drum Lambert skeleton hoist.
1—6½x12 double drum Mundy hoist.
1—Stiff-leg derrick 15-ton capacity with 65-ft. boom.
1—Stiff-leg derrick 15 ton capacity with 60-ft. boom.
1—Stiff-leg derrick 5-ton capacity with 50-ft. boom.
1200 Linear feet of Lakewood chutes.
2—No. 3½ Keystone well drills.

About 45,000 yds. of concrete are required under the present contract, and the cost of all items will amount to about $525,000. The principal unit prices are as follows:

Loose Rock Excavation..	$ 4.69 per cu. yd.
Solid Rock Excavation...	6.67 per cu. yd.
Concrete for Balustrades.	20.60 per cu. yd.
1-2-4 Mass Concrete.....	11.85 per cu. yd.
1-3-6 Mass Concrete.....	10.34 per cu. yd.
Steel Reinforcement	.04¾ per lb.

A total of 50,800 cu. yds. of 1-2.5-5 and 1-2-4 concrete were placed under a previous contract, the cost of all work under which amounted to $527,000. The total cost of the dam from bottom to top is, therefore, $1,052,000.

The writer is indebted to Mr. C. K. Allen, Resident Engineer, for a portion of the information contained in this article.

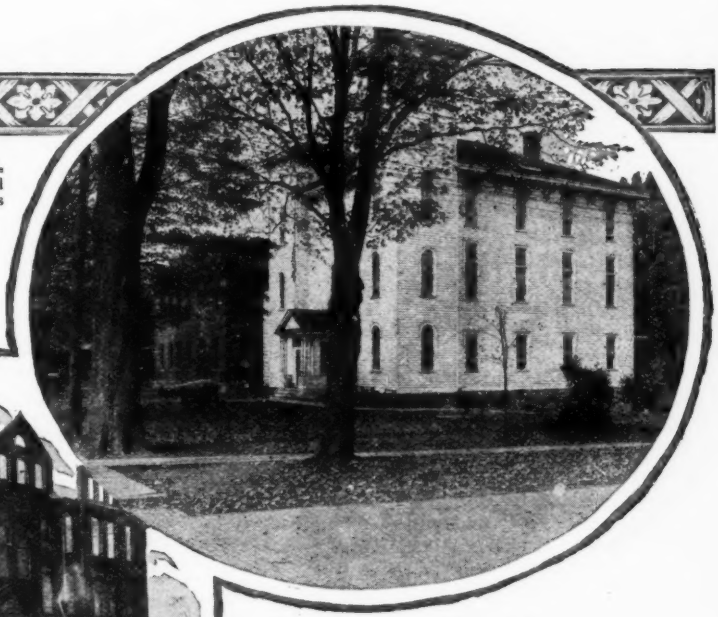
The foregoing paper by Mr. Megraw was presented at the recent annual convention of the American Water Works Association.

COMBINATION OF THE LIME-SODA AND ZEOLITE WATER SOFTING PROCESSES

To the Editor: The testimony in favor of the Centralized Softening of a Public Water Supply, as set forth in your March and April issues, seems to be unanimous. It is difficult to see how contradictory evidence on this subject can be produced.

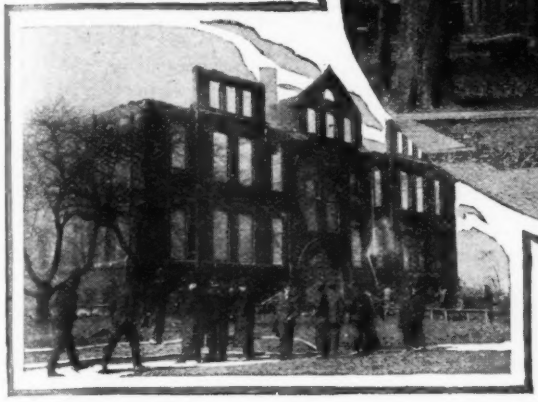
Your fourth question, with respect to a choice of methods, has brought from Mr. Charles P. Hoover of Columbus, Ohio, the outline of one of the most promising methods, namely, the combination of the lime-soda and zeolite softening processes.

However. I cannot agree with Mr. Hoover that a residual hardness of 85 parts per million is to be considered satisfactory. As a result of more than 20 years'



Three story wood school building at Arcade, N. Y. Heated by waste steam from the town's electric light plant.

The daily press tells us repeatedly of hazardous school fires from forced heating systems.



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THIS school building had six separate furnace fires in the basement, and the top floor could not be occupied due to existing fire hazards.

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Steam, easily regulated as required, is now charged for by meter in the same way as gas, water or electricity.

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experience in designing, building and operating water softeners, I would say that this limit is too high. Few satisfied users who operate their own lime-soda plants are content with a hardness of less than 50 parts per million. Many attain a lower hardness. These and others will gradually become dissatisfied with a 50 parts limit as soon as the possibilities and advantages of softening to appreciably lower limits are realized.

While no doubt many of the early water softening installations have given rise to some annoyance owing to after-precipitation in mains and service piping, later developments in water softening have rendered practical the elimination of such difficulties. No municipality should hesitate to install a softening plant because of the fear that after-precipitation will accumulate in the pipes. At least three methods of correcting any trouble of this sort are freely available to any who would apply them. Very truly yours,

L. M. BOOTH,
President, The Booth Chemical Co.
Elizabeth, N. J., April 29, 1922.

LIGHTING THE MIAMI, FLORIDA, CAUSEWAY

By E. T. Austin, Lighting Specialist, General Electric Co., Schenectady, N. Y.

The causeway joining Miami, one of Florida's leading cities and a winter resort of nation-wide fame and popularity, with its sister community of Miami Beach, is now lighted throughout its entire extent by G-E Novalux highway lighting units. The result is that this stretch of roadway, over which cars sometimes pass at an average rate of 1,000 per hour, with the consequent discomfort and sometimes danger which such congestion means, now offers safe and comfortable motoring conditions.

Built by Dade County several years ago, this causeway is approximately 3½ miles long. One side is given over to the use of trucks, the other to more rapidly moving vehicles, and the center to trolley car tracks. The congestion of travel over it is apparent from the fact that a recent tabulation showed that on one day, between 7 o'clock in the morning and 7 o'clock in the evening, 12,410 automobiles entered and left the city over this thoroughfare—an average of more than 1,000 per hour.

The desirability of lighting the causeway to remedy the danger of driving over it by night was recognized, and efforts were made several years ago to provide an illumination system for it. It was found, however, that with the equipment then available for the purpose the expense both of installing and maintaining a system that would furnish adequate lighting would involve a large sum.

Hence the improvement remained in abeyance until Mr. R. I. Ellis, manager of the Miami Beach Electric Company, learning of the success of the G-E Novalux Highway unit in one of its early installations, obtained several of the fixtures and installed them on the causeway. So effective was the lighting they provided and so easily and safely could cars be driven at night after they were placed, that Mr. Ellis and the Miami Beach Chamber of Commerce laid the matter of lighting the entire causeway before the County Commissioners of Dade County, in which county both communities are located.

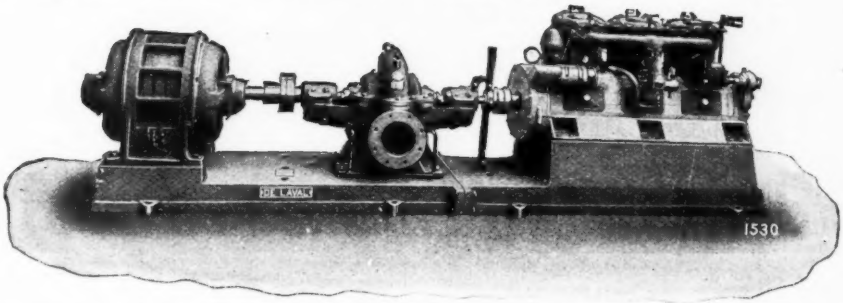
The county commissioners immediately authorized the purchase of 45 more units, which were received and installed within two months. They were mounted on pole extensions which places them 30 ft. above the roadway, and spaced at intervals of 400 ft. except on curves, where the spacing is 300 ft. Each unit is equipped with a 250-candlepower, 6.6 amp. Mazda "C" lamp. The maintenance expense of the system, based on a fixed charge per lamp per year, is assumed by the two cities, Miami paying two-thirds and Miami Beach one-third.

The intensity of the light given by these units is such, and its distribution is so even, that motorists are able to drive over the causeway at 30 miles an hour without head-lamps.

The fixture used for this installation—the Novalux highway lighting unit—is the same as that employed in lighting Paradise Road, Swampscott, Massachusetts; the Albany-Schenectady highway; roads in the vicinity of Detroit, and elsewhere, and which it is proposed to install on the Ideal Section of the Lincoln Highway, in Lake County, Indiana.

Miami is visited annually by thousands of tourists, a very large percentage of whom are keenly interested in highway improvement and in whatever will make motoring safer and more comfortable. They represent every section of the United States, and various foreign nations. Hence this installation is of especial interest, as it affords an opportunity for motorists from far and wide to see for themselves the value of highway lighting.

Duplicate Power Supply for Pumping



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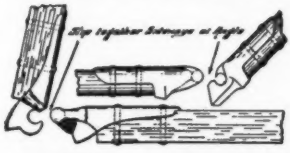

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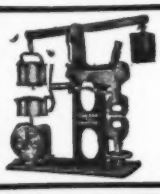

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Construction News and Equipment

NEW ARRANGEMENT OF EQUIPMENT ON CONCRETE ROAD CONSTRUCTION

A complete material handling unit has been worked out by the Portable Machinery Co., of Passaic, N. J., consisting of their contractor's type Scoop Conveyor, specially designed to handle abrasive material, a portable measuring hopper and an auto dump truck. This outfit handles all the materials this side of the concrete mixer and cuts the usual shovel and wheelbarrow gang by 10 or 12 men and keeps the mixer operating at full capacity.

Referring to the accompanying sketch diagram, the stone and sand is first placed in suitable piles along the roadway. One conveyor with a measuring hopper is assigned to the crushed stone and a duplicate outfit is assigned to the sand and cement. Both measuring hoppers are adjustable in size in order to provide for mixtures of different proportions.

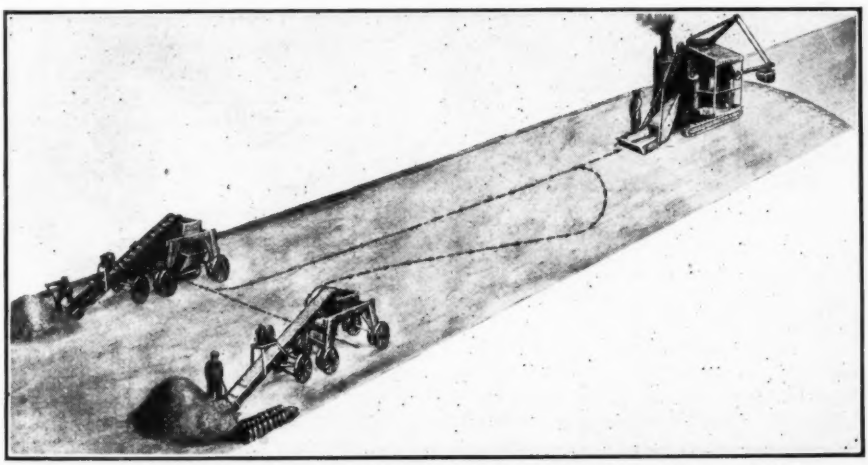
The man in charge of the stone handling outfit fills his hopper with the desired proportion of stone and the man in charge of the sand and cement handling outfit fills his hopper with the correct proportions of sand and cement.

After the measuring hoppers are charged, the dump truck operator drives under the stone hopper and receives the charge of stone, after which he drives under the sand and cement hopper and draws these materials on top of the stone. The load is then driven to the concrete mixer and discharged into the mixer hopper, and by the time the driver comes back to the measuring hoppers, they are filled and ready to discharge their next load. It will be seen that this method of handling provides an unusually flexible arrangement.

The conveyors and measuring hoppers are easily moved backward or kept in close contact with the piles of material scattered along the roadway.

On large jobs it is advisable to use more than one auto dump truck, especially if a speedy concrete mixer is used or if the mixer and measuring hoppers become located far apart.

On small jobs, one conveyor, one hopper and one truck can be used. In this case the stone and sand should be placed close together along the roadway, so that both materials can be fed into the same conveyor. One man is required to feed the stone to the conveyor and a second man to feed the sand and cement. The man handling the sand, feeds a certain number of shovelfuls to the conveyor, after which he stops and adds the cement, while the man feeding the stone continues feeding until



SKETCH SHOWING USE OF PORTABLE BELT CONVEYORS, MEASURING HOPPERS AND MOTOR DUMP TRUCKS ON CONCRETE ROAD CONSTRUCTION.

the hopper is full. If desired, the cement can be added at the mixer skip.

The ideal outfit is two conveyors, two mixer hoppers and two auto dump trucks. This provides a double unit, and if anything goes wrong with any part of one unit, the second unit will always keep the mixer going.

Again, it may be desirable, at certain intervals, to use one of the conveyors to handle stone or sand from railroad cars or from storage piles to the trucks that must first convey these materials to points along the roadway. Both the conveyors and measuring hoppers are manufactured in various sizes by the Portable Machinery Company, of Passaic, N. J.

A NEW ROAD REPAIR HEATER

A portable heater and mixing machine, for road repair work, has been developed by the Road Repair Equipment Co., 165 Broadway, New York City, of the type here illustrated. It is of sufficient size to repair in one operation a hole 3 cu. ft. in size. It is small enough to be handled by one man.

The heater is similar to a wheelbarrow, having a special body containing a secondary solid body or tray, with a predetermined space allowed between the tray and the special body. In this space there is mounted a gasoline burner, from which a hot flame spreads over the bottom of the tray, producing a uniform heat

A NEW ROAD REPAIR HEATER.

throughout the area of the tray. This gasoline burner is fed from a tank mounted on the handles of the heater immediately in front of the body, permitting free use of the handles, and coincidentally protecting the tank from any damage. Attached to the tank is a hand force pump for application of air to the gasoline for proper mixture.

By a needle valve the proper flow of gasoline to the burner may be controlled by the operator to any desired heat. By this means if the operator desires to put the heater out of service for a time, he can lower the flame and save gasoline. The heater may be put back into instant service by simply turning the needle valve.

By the use of this improved heater a large supply of stone and bituminous materials may be placed along the road at different intervals, and the patrolman, inspector or workman starts out in the morning with the heater, loading his heater with stone, bituminous material and tar, and, upon reaching the first hole, lights the heater, heating the mixture, turning it over with a shovel until the proper mixture and heat is reached, then dumps the mixture into the hole, levels and tamps it into proper place. The complete operation of loading the heater, heating the materials, mixing, dumping and tamping requires less than five minutes.

It is claimed this machine can be used in extreme cold weather, as the heating is always uniform. If used immediately when a portion of road starts to break or disintegrate, it would keep the road constantly in good condition and save sending large gangs to make extensive repairs later on.

It is claimed that this road repair heater is well adapted for the less populated districts, where the patrolman is situated a long distance from the central plant.

OPERATION OF A COUNTY MAINTENANCE ORGANIZATION ON GRAVEL ROADS

By Sam Steigerwalt, County Engineer, Nevada, Iowa.

The selection of the ideal maintenance equipment and the plan of operating it is still a problem with most all of us. This fact is very well illustrated by the 99 different methods used in Iowa to maintain our roads. Equipment and methods used in one county will have no friends whatever in an adjoining county having practically the same kind of road surface and road conditions to work with.

In Story County we have tried out several different kinds of equipment and are now trying out others, with the expectation of changing if somebody finds something better than we have at present.

Our Primary System is composed of one road straight across the central part of the county east and west, and one near each side of the county running north and

south, totaling 64 miles, divided into two patrol districts or patrol headquarters. Two men located at Ames with one Quad truck, one Ford truck, one Cletrac tractor, one 8-ft. Adams grader, with a 12-ft. blade, two 12-ft. drags, and several smaller drags, take care of 24 miles. They do all of the dragging on the 9½ miles between Ames and the Polk County line, and all necessary patrol work other than dragging on the other 14½ miles. We aim to keep teamdraggers on about one-half of the primary road, as these can be hired by the mile and work only when dragging is necessary, while if we kept patrol men enough to do all of the dragging within 24 hours there would not be work enough to keep them busy between draggings, and the total investment in equipment would be more than doubled.

At Nevada we have four men, a foreman, a mechanic, a grader man and a truck driver. They are all truck drivers when necessary and do their special work when that kind of work comes up. Equipment at Nevada consists of one Nash Quad, two F. W. D.'s, one Packard, one Ford, one 12-ft. Adams Reclamation ditcher, one 20:35 Twin City tractor, three 12-ft. drags and several 10-ft. drags.

Twenty-three miles are kept dragged by the Nevada squad, and patrol work other than dragging is done on the balance of the district. This squad also does most of the small repairs on wood bridges over the county, builds inlets and hauls tile and fills tile ditches on the County Road System, besides doing most of the repairs on all of the county trucks, tractors, blade graders, drags, etc.

All of the large trucks are equipped with cabs or storm aprons, and as soon as it starts to rain, at least three trucks are sent out to drag the center of the road to keep the ruts and pot holes from forming an holding water to soak up the roadbed.

For this kind of dragging we are using one Engle 10-ft. drag behind each truck. These drags are long enough to cover the center of the road in good shape and will let the traffic by on one side and do not extend out so far on the other side as to hook into the loose heavy gravel and earth on the shoulder. The trucks travel along about 4 or 5 miles per hour on intermediate speed and do a real job of keeping the roads in shape during a continued rainy spell, when no other equipment could be out in the weather.

As soon as the rain stops two trucks are started out together with two 12-ft. drags or a blade grader and one 12-ft. drag. They cover practically the whole road and keep far enough apart to let the traffic work around one on the right and around the other on the left.

The drags are adjusted so as to drag either in or out, as the road requires. These two trucks will go out from 12 to 14 miles and back in a day, and on the return trip the road, which is now getting almost dry, gets a double dragging.

The next day, if the weather continues cloudy, and the road stays damp, one truck makes another trip with a 12-ft. drag and smooths up the soft places.

During dry weather, just enough dragging is done to keep the traffic spread out over the road surface and prevent ruts from forming. Taking the entire season through, about one-third of the patrolmen's time is taken up dragging.

Our primary roads are all well drained, approximately 500,000 ft. having been placed on the 64 miles.

At present 43 miles have been graveled, and during 1922 14 miles will be given the first coat and 9 miles a maintenance coat.

The patrolmen have hauled about 400,000 ft. of the tile placed; they have filled all of the tile ditch, have spread and worked practically all of the gravel placed, and two men, with the 20:35 Twin City tractor and a 12-ft. Adams grader, working about two days a week during the summer months, have kept the earth roads shouldered up and flat on top, just ahead of our graveling operations.

Gang maintenance on primary road consists of hauling maintenance gravel, which is all done by contract, and tractor grading, which is also done on contract by the hour. In the spring of 1921 the county purchased a 12-ft. Adams Road King with back-sloper, and contracted with H. R. Hilleman, of Marshalltown, to furnish a new 40:60 Twin City tractor and two men to run the outfit at $6.50 per hour for actual time put in. This work consisted of following up the completed drainage and widening the crown out to 28 ft. and building up square shoulders and a flat top preparatory to graveling. Later in the season we widened out 9½ miles of graveled road and scarified the surface and built up the shoulders preparatory to placing a maintenance coat of gravel. This season we have 16 miles of good gravel road that has too much crown, and we are going to widen out and build up the shoulders without scarifying, as we do not expect to place any maintenance gravel on this section this season.

During 1921 this outfit covered 37 miles at a cost of about $200 per mile.

All of the team dragmen are supplied with 10-ft. Engle drags and are paid 40 cts. per mile traveled.

The patrolmen are paid 40 to 50 cts. per hour for actual time worked and will average about $1,000 per year per man.

During 1921 Story County paid out for maintenance on Primary Roads the following amounts:

For patrol maintenance.....	$16,232.14
For gang maintenance.....	30,482.02
For equipment and tools.....	5,954.68
Making a total of.....	$52,668.84
Making an average per mile of..	$ 819.74

The above amount includes tractor grading on 26 miles, maintenance gravel on 26 miles, and a great deal of clearing and grubbing, excavating for inlets, smoothing up tile ditch filling, shouldering up for graveling, and other work which really was construction work in that when once done it is done for a long time.

The 131 miles of county road are divided into 7 districts of 14 to 22 miles each, with one patrolman with team in each district. He is equipped with a small blade grader, slip, plow and dump boards for his wagon, and receives 60 cts. per hour for actual time put in.

These team patrols do very little dragging, as practically the entire county system is covered by farmer dragmen, with teams or small tractors.

They haul gravel for patching short stretches of road, keep the loose gravel worked in, and the grass and weeds scraped from the outside edge of the shoulder, keep the culverts and tile inlets clear of rubbish, and other odd jobs found necessary.

The county maintains two large tractor and grader outfits for shaping up the shoulders of the County Road System. This work cost approximately $200 per mile during 1921.

The total cost of maintenance on the County Road System during 1921 was $34,388.16, or approximately $262.50 per mile, of which $147.43 per mile was for patrol maintenance and the balance for gang maintenance.

We are at present trying out a home-made steel drag, also a large size Iowa Maintainer, and I believe that both of them are going to show results as to efficiency and economy of operation.

The foregoing paper by Mr. Steigerwalt was presented at the recent annual conference of Iowa road officials.

MINNESOTA'S SUCCESSFUL NEW HIGHWAY DEVELOPMENT PLAN

With motor vehicles turning in the bulk of the new money Minnesota broke the previous road building records of the State in 1921, under a plan devised by Charles M. Babcock, State Highway Commissioner. The State used more than $28,000,000 for 1921 highway improvement and maintenance, compared with about $16,500,000 in the previous banner road building year.

Increases in taxes on motor vehicles for highway improvement and upkeep, friends of the plan contend, are more than offset by savings on repairs, tires, gasoline and other car and truck operation costs.

The Babcock plan of highway development is attracting nation-wide attention, partially because of results during the first six months of operation. Graded and gravel-surfaced mileages on Minnesota's primary system of highways have been increased 40 per cent. plus and the paved mileage has been almost doubled, over improvements listed when it was transferred to the State. Relieved of the expensive burden of arterial highway construction and upkeep, counties and towns have more funds available for use on the secondary system or feeder roads.

Babcock Presents Plan

The Babcock plan was brought out by rapidly increasing motor vehicle traffic, which demanded modern roads as it wore out the old turnpikes. Counties and towns were spending every dollar available to keep main roads passable under the growing grind of heavy, high-powered cars, and secondary roads were more or less neglected. The necessity of providing adequate roads was generally recognized; nevertheless, increases in road tax levies were opposed.

Commissioner Babcock presented his plan.

"Let wheels using the highways pay a fair share of road improvement and upkeep expense," he proposed. "Put a heavier tax—the average was $10.60 a year, including the license fee of $5 for three years—on each automobile and truck, and use the proceeds to build up and maintain the trunk highways. Good roads will enable car owners to save more than the tax on repairs, tires, gasoline—"

The automobile owners favored the

idea. Engineers' tests had demonstrated big savings possible in the operation of motor vehicles on good roads over poor roads. Motorists wanted good roads.

"Use the motor vehicle tax revenue and federal highway aid on the trunk roads," Commissioner Babcock continued. "Leave the counties and towns all local tax funds and state highway aid for the secondary or feeder roads. Without the expense imposed by the main highways, they will be able adequately to improve and maintain the feeders. It is primarily a farm-to-market roads plan."

Farmers, too, favored the plan as it was understood. Business and professional men and other citizens fell into the line. Good roads represented an urgent need.

Public demands for better highways became more and more pressing. Funds were insufficient to meet them. Under the state constitution highways were improved and maintained solely by counties and towns; the state was without authority to spend a single dollar, were it available, on actual highway work.

Roads in Minnesota, as in other states, were years behind traffic demands, and going steadily backward. The county system on arterial routes brought patch-work development to emphasize the need of state control of interstate and intrastate arteries.

Commissioner Babcock sought so to provide in his plan.

Amendment No. 1 on Ballot

The Minnesota Legislature of 1919 submitted to popular vote, at the following general election, Good Roads Amendment No. 1, proposing to effect the Babcock Plan.

First, the amendment proposal was to create and establish a system of trunk highways, to be constructed, improved and maintained forever by the state. Specified routes approximated 7,000 miles and connected county seats and important towns of every section, and also the famous ten thousand lakes and other recreational regions. Additions would be permitted upon completion of 75 per cent. of the mileage.

Secondly, the state trunk highway fund was created to finance trunk system operations. It included federal aid allotments and the proceeds of a more onerous tax on motor vehicles using the highways, in lieu of personal property and other levies except city wheelage taxes. A further provision was for the authorization of trunk highway bond issues to run not to exceed 20 years and to limit to $75,000,000 the amount that might be lawfully outstanding at any one time.

Borrowed funds are being used on the trunk system, although the state has issued no highway bonds. To insure against cessation of work by counties on the trunk routes in anticipation of adoption of Amendment No. 1, the Legislature of 1919 also authorized counties, under certain restrictions, to issue up to $250,000 each of bonds, proceeds to be expended on the trunk highways, and virtually pledged reimbursement by the state. Many counties acted under the law.

Adopted by Huge Majority

Good Roads Amendment No. 1, carrying adoption of the Babcock Plan, was passed Nov. 2, 1920, by a vote of 526,936 to 199,603. The big majority was attributed in part to an educational campaign in which the newspapers of the state took an important part, and which was directed by the Minnesota Highway Improvement Association.

Legislature Provides Machinery

The Babcock Plan was made effective by acts of the Legislature of 1921. The State Legislature made a far-reaching investigation to determine the relative merits of the single commissioner or board system, with the result that the single commissioner plan was continued.

Motor vehicle tax schedules were given extensive study by legislative committees. Rates finally adopted were based upon factory list prices, with depreciation allowances of 25 per cent. for 3 and 4-year-old machines, and 50 per cent. on cars 5 years old or older.

The passenger car rate is 2 per cent., with a $12 minimum, and the truck rate 2¼ per cent., $15 minimum. The average was estimated at less than $20 a year. Dealers are assessed $25 a year for licenses and charged nominal fees for extra license plates for cars which can be used lawfully only for actual demonstration purposes. Dealers in used cars must pay regular rates on cars remaining in their possession after Nov. 1. Taxes for the last six months each year are at half rates. Penalties attach for delayed payments. Motor vehicle taxes are collected and license plates issued by the secretary of state.

General highway statutes were completely recodified to correlate new sec-

tions with those affecting the local highway authorities. The measures were passed with big margins in both branches of the legislature.

Highway Program Speeded

Governor J. A. O. Preus signed the bills April 25, 1921, and announced the reappointment of Commissioner Babcock under the new laws, effective immediately.

The commissioner and his aides started at the zero mark. Lack of funds and authority precluded any preliminary work in advance of enactment of the highway bills. The construction season was well opened and policies and projects remained to be decided.

Commissioner Babcock named Mr. Mullen chief deputy and highway engineer. Experienced men already identified with the department were retained, and the list included J. T. Ellison, bridge engineer; W. F. Rosenwald, maintenance engineer; O. L. Kipp, construction engineer, and F. C. Lang, engineer in charge of tests and laboratories.

From the small nucleus a greatly enlarged administrative force was built up. County road engineers, familiar with local conditions in various sections, were added to the staff, filling the positions of eight division engineers and sixteen district maintenance superintendents. Offices of the highway department spread to spaces on six floors of a St. Paul building; then a capitalist friend offered to erect the department a home, which is nearing completion now.

All energies in the department were centered in one direction: to start field operations on the earliest possible date—"to make the dirt fly."

Effective Maintenance First

"The first move must be toward putting and keeping every part of the 7,000-mile trunk system in good, passable condition," Commissioner Babcock ordered. Immediate steps followed to put into the field a maintenance force organized along lines worked out several years previously by Engineers Cooley and Mullen. The latter had outlined the plan at a convention of highway engineers and it had been partially effected in a neighboring state with successful results.

The purpose was to extend early benefits to every locality of the state by providing a constant-duty patrolman or roadmender for each 5-mile section of the trunk highway system. Every patrolman must live in or near his "beat" and furnish his own team or tractor, grader, drags and other tools. The going wage is paid the patrolman and they receive an allowance for rental of equipment, the latter method being adopted to insure better care of tools.

More than 1,200 patrolmen were covering about 6,200 miles out of the 7,000-mile system within 60 days, according to official records. In some cases the patrolmen worked to disadvantage at the start because of poor foundations, and state fleets of heavy outfits were ready to help them.

War Equipment in Service

Fleets were made up of 50 tractors and 150 trucks—part of the surplus war equipment turned over by the Federal Bureau of Public Roads. The trucks were overhauled and fitted with hoist bodies for handling gravel, and the trucks converted to constructive work, in big machine shops maintained by the highway department on the state fair grounds.

Extensive use of heavy machinery made a sharp demarkation between the old and new methods on trunk highways. The combined equipment was found equal to dressing up roads at the rate of 5 miles a day. The tractors drawing heavy blades would shape up and make a good wheel track and the trucks follow on to add a surfacing of gravel.

The maintenance system soon began showing results, a spirit of friendly rivalry having been created among patrolmen to elicit their best efforts. The public ordinarily judges a road by its riding qualities, the highway officials explained, and a new standard of smoothness over the system was being generally commented upon and winning more friends for the new good roads movement.

New Construction Launched

New construction projects were undertaken with the maintenance plans well started.

"Improvement of poor sections in long mileages of otherwise good roads—strengthening of weak links in the chain—will be the initial aim," Commissioner Babcock announced.

With Mr. Mullen, possessing first-hand knowledge of conditions and needs through long experience in the department, the commissioner toured more important trunk routes by automobile, averaging 200 miles a day.

New construction projects were listed by the executives in the field. Orders were wired to St. Paul headquarters.

Survey parties were rushed out in all directions to procure necessary engineering data. When undertakings were ready and estimated at $1,000,000, the group was advertised for bids and wide competition was obtained.

The low bids were most reasonable, engineers announced at the time. Paving was contracted as low as $28,300 a mile, while other states were reported fighting for proposals under $30,000 a mile without success. Correspondingly low figures were secured on grading and gravel-surfacing, ranging from 40 to 50 per cent. under those paid by counties the year before, and almost back to pre-war levels, it was stated.

Operations in Full Swing

As in the maintenance department, so also in the construction department, progress charts on July 15 showed contract jobs under way on a large scale. Nearly 75 projects, running well above $5,000,000, were going forward in almost as many widely distributed sections of the state.

One big handicap was forced curtailment of the program for the first regular season. The State Legislature had authorized no issues of trunk highway bonds and federal highway aid was not forthcoming as anticipated.

Reimbursement bonds, previously referred to, had been voted, however, by a number of counties, and large balances were available to help the department enlarge the first season's operations.

County officials concluded, however, that in any event the state would keep up and gravel the trunk routes, and insisted as a rule that bond money be used for hard-surfacing. This resulted in an abnormal amount of paving during 1921.

Approximately $7,500,000 of reimbursement bond money was used and some counties gained precedence in local improvements on the system.

Funds Exceed $28,000,000

Under the new scheme Minnesota was using more than $28,000,000 a year for road building and upkeep, against about $16,500,000 maximum under the old plan.

Motor vehicle tax revenues were running up to the $6,000,000 total expected, and with the reimbursement bond money, the trunk funds aggregated $13,500,000. Federal aid later added $2,123,000 to the trunk fund. Counties and towns were furnished more than $12,500,000 for exclusive use on the secondary highway system—about $11,000,000 of local tax revenues and $1,650,000 of state aid.

The first season of operation under the Babcock plan, with unusually favorable construction conditions, insured a banner year for general highway development in Minnesota.

When the trunk highway system was transferred to the state it was listed with 1,499 miles graded, 1,371 miles graveled and 112 miles paved, the balance being in lesser degrees of advancement and mainly of good dirt roads. Adding 103 miles of hard-surfacing, the state department nearly doubled the paved mileage, while the graded mileage was extended by 680 miles and the gravel-surfaced mileage by 438 miles, all within 6 months. Also, maintenance forces reshaped 713 miles and regraveled 462 miles.

The expenditures approximated $4,758,-026 for grading, $1,605,122 for graveling, $3,549,259 for paving and $514,047 for bridges, and with the $3,000,000 set aside for maintenance, made the regular season total of $13,426,454 on trunk routes and exclusive of betterments on the secondary road system.

Reaches for More Work

The construction season well advanced, highway aid legislation still dragged in Congress. Commissioner Babcock saw a serious unemployment situation looming, and a possibility of big relief through carrying highway operations through the winter months.

The "more work—better roads" movement was started in Minnesota and an effort made to enlist the co-operation of other states. Herbert Hoover, Secretary of Commerce, already was urging action in that direction, and the Minnesota Highway Department was calling the possibilities to the attention of local road authorities throughout the state. Much road work could be done even more economically and advantageously in winter, it was pointed out.

Commissioner Babcock was appointed a member of President Harding's conference on unemployment. He went to Washington with concrete figures on possibilities offered by winter work on Minnesota highways. The proposal was the basis of an outstanding recommendation by the conference.

Minnesota officials, commercial, civic, labor, farm and other organizations and public-spirited citizens assisted by petitioning officials at Washington to speed action on the highway legislation and

newspapers again helped gain practical results.

The federal highway aid was assured and Commissioner Babcock resigned as regional director for President Harding's conference to speed the state program of winter work on highways.

$4,500,000 of Winter Work

A ruling was given by Clifford L. Hilton, Minnesota Attorney General, that the collection of motor vehicle taxes might lawfully be anticipated to match federal aid. Commissioner Babcock's tentative plan is to use about $4,500,000 on winter work, to hasten needed road improvements and prevent forced idleness among workingmen and avert suffering among their dependents.

Bids early in December on 44 widely distributed projects, estimated at $2,293,500 and covering more than 300 miles, were called for within 10 days after Congress voted federal aid. Deputy Mullen continued conferences with construction and division engineers to add more jobs to the lists without unnecessary delay.

Heavy excavating with steam shovels, distribution of gravel and other materials predominates, the work proposed to furnish jobs for hundreds of men.

Save for actual permanent construction, highway funds are being conserved for heavy-traffic season benefits, highway officials explain. Accordingly, snow removal and other winter work is being limited.

Bigger Benefits Indicated

Formal opening of the first 100 miles of continuous pavement on the Minnesota trunk highway system was celebrated Nov. 15, 1921, at St. Cloud, the northern terminus of the paved way. Speakers took occasion to compliment the highway department on first year achievements under the Babcock Plan, and plans were reported that the longest continuous pavement another year will be nearly doubled in length.

Minnesota people take pride in the Babcock Plan. Automobile owners are unstinted in their praise of improved road conditions in virtually all sections of the state. Farmers begin to see fulfillment of the "farm-to-market road" forecast. Tourists in increasing thousands roll in from other states to the numerous recreational regions and join in lauding Minnesota's good roads.

The importance of adequate highways and the benefits sure to follow them are appreciated in Minnesota.

MOTOR TOURIST CAMPS

"What goes to make an ideal camping ground?" This question has been answered by L. P. Strothman, engineer and map designer and head of the United States Touring Information Bureau, Waterloo, Ia. After a survey of the camping grounds in all sections of the United States, Mr. Strothman has issued the following specifications for the guidance of city and town officials:

"Camping grounds should be easily accessible from the business section. Signs should be placed about the business section and on roads leading into town to direct tourists to the grounds.

"Signs in the grounds should direct tourists to a reliable source of touring information and other signs should give rules and regulations plainly.

"Wooded ground is preferable and much more pleasant. Natural drainage is essential, and when possible the camping grounds should be on high rather than low ground in order to afford protection from insect pests.

"Permanent shelter would be appreciated by every tourist in event of inclement weather, and will add much to the value of the grounds as an advertising asset for the city. Such shelter should have a smooth floor surface. Stoves should be set up and maintained in usable condition.

"Sanitary toilets, with due respect to decency, should be provided.

"Garbage cans are essential and signs should be posted commanding that refuse be deposited in designated places.

"Fresh water should be piped from the city supply. If this is impossible, then deep well water should be available.

"Fuel should be attainable. In many cities wood is cut and corded in the grounds by order of park officials.

"A few lights about the grounds and in the shelter will be appreciated by tourists. Whenever possible, telephone facilities should be available.

"Some form of protection is always desirable. If a caretaker cannot be afforded, then direct communication with the police station should be established.

"Access to bathing beaches, fishing waters and other amusements will be enjoyed by tourists.

"A good camping ground is a valuable asset to any town or city, and any money expended in making it of real service to tourists will not be wasted."

CREDIT FOR AUTHORSHIP

Due to an oversight in the mechanical preparation of the May issue of this magazine, credit was not given to Mr. John F. Druar, of the firm of Druar & Milinowski, Consulting Engineers, Globe Bldg., St. Paul, Minn., for the authorship of the article beginning on page 29 and entitled: Facts and Figures Indicate That Now is the Time to Install Public Improvements. As the article was written for the exclusive use of this magazine the editor naturally regrets that the usual credit lines on authorship were omitted in the make-up of this very interesting and timely article.

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Contracts Awarded

ROADS AND STREETS

Ala., Montgomery—Alabama Construction Co., Montgomery, awarded contracts as follows: Monroe Co., 8.23 mi. gravel road betw. Jones Mill and Monroeville, at $34,405; Fennell Co., Tuscaloosa, Ala., awarded contr. for 10.29 mi. penetration macadam, balance gravel; total 13.5 miles; $223,814.

Cal., Maricopa—Federal Constr. Co., Call Bldg., San Francisco, awarded contract for paving California, Main, Center, Kern, Hazeltine, Klipstein and Poso Sts., at $115,800.

Cal., Sacramento—Richmond-Page & Co., San Francisco, awarded contract for grading state highway, Lake Co., bet. West boundary and Upper Lake (about 9 miles) at $167,359; W. A. Dontanville, Hollister, contract for paving state highway in San Benito Co., bet. San Juan and Pajaro River (4.6 miles cem. conc.), at $47,802.

Cal., Sacramento—Grant-Smith & Co., 708 Balboa Bldg., San Francisco, awarded contract for paving with bitum. macadam 11.73 mi. state hwy., Sonoma Co., at $169,366.

Cal., San Francisco—W. A. Kettlewell & Sons, Oakland, awarded contract for impvt. of so-called Cuesta Grade betw. San Luis Obispo and Santa Margarita—about 3.5 miles, at $78,205. State will furnish materials at $99,920.

Del., Dover—D. E. O'Connell & Son, Ridley Park, Pa., awarded contr. for Contr. CN-6, 5.137 mi. Glasgow-Bear Sta., at $148,815; Wm. P. Staats, Phila., Pa., awarded contract for Contr. CS-15, .71 miles thru Hillsboro, Sussex Co., at $22,237; Benjamin Franklin, Jr., Philadelphia, contract for Contr. CS-17, 3.33 miles, Cokesbury-Church-Cloverdale Cross Rds., at $104,227; Jas. A. Hirons, Dover, contr. for Contr. No. 45, 1.65 mi. Camden-Cooper's Co., Kent. Co., at $61,213.

Fla., Jacksonville—Thos. Bryan, Fort Lauderdale, awarded contract for road work in Palm Beach Co., section of Okeechobee cross-state rd. from bend in West Palm Beach canal to Belle Glade on Hillsboro canal (20 miles), at $190,000.

Fla., St. Petersburg—Georgia Engr. Co., Augusta, Ga., awarded contract to pave 43,840 ft. with vitr. brick, at $306,652.

Fla., W. Palm Beach—Tom. Bryan, Ft. Lauderdale, Fla., awarded contract to improve road; install culverts and surf. 20-mi. Okeechobee Rd., from Mile Post No. 21 to Belle Glade on Hillsboro Canal at $190,000. Conglomerate material of marl, rock and shell, 24 ft. wide.

Idaho, Coeur, d'Alene—Fiorito Bros., Seattle, awarded contr. for paving Apple Way from city limits to Idaho-Washington line, at $295,818.

Ill., Danville—Vermilion County let contract for paving 15-D Rd., Sects. T, U, V, W, X and Y to Osborn, Allen & Hegg, Covington, Ind., at $53,471; Bishop & Curdle, Danvile, at $145,981; H. H. Lewis & Co., Hoopeston, at $97,462.

Ill., Waukegan—Following contracts let: Rockland Rd., to Eclipse Constr. Co., Lake Villa, Antioch Rd., to Geo. Wade; Lake Zurich-Wauconda Rd., to Fred Nelson. Addresses of contractors and amt. of their bids are as follows: Nelson, 1244 Marquette St., Racine, $120,525; Wade, Kenosha, $79,031; Eclipse Constr. Co., Winnetka, Ill., $78,052.

Ind., Indianapolis—Chicago Heights Coal Co., awarded contract by State Hwy. Comn., Indianapolis, for concreting Dunes Hwy.—Mich. City to Baileytown—10.7 miles, at $206,145.

Ind., Ft. Wayne—Moellering Constr. Co., awarded contract for con. of Lima Rd., at $362,374.

Kans., Topeka—List & Hallock, Kansas City, Mo., awarded contract for paving 10.2 miles Topeka Ave., road from city limits to Osage Co. line, at $314,059. Work includes grading and culverts. Surface will be of concrete.

Md., Hagerstown—Thomas, Bennett & Hunter,

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awarded contract to construct 11 miles conc. shoulders on Frederick Rd. bet. Ridgeville and Lisbon, at $101,660.

Mass., W. Springfield—Adams & Ruxton Constr. Co., 33 Lyman St., Springfield, awarded contract for paving, grading and finishing west approach to new Conn. River brdg., at $106,389.

Mich., Benton Harbor—St. Joseph Constr. Co., awarded contract to build the Meadowbrook hwy. in Bainbridge, Benton and Pipestone Twps., at $63,696, also contr. for Hillendale Rd. so., 6½ mi., at $94,000, Sodus Twp. Snyder Bros. awarded contract for impvt. of Hillendale Rd. north, Benton Twp., at $55,000. All the roads will be built of macadam and be 12 ft. wide.

Mich., Detroit—Rockford Constr. Co., Rockford, Ohio, awarded contract for bldg. 1.1 mi. rd. in Dundee Twp. 18 ft. wide with 8 ins. conc., at $16,179; state to furnish cement; Hilding & Rabe, Grand Rapids, awarded contract for constr. of 7.3 mi. Ida-Bedford Rd. 18 ft. wide, 4-in. macadam base and 8 ins. conc. at $181,000; W. H. Knapp, Monroe, awarded contr. for constr. of 8 7-16 miles of north end of Flat Rock pike, 20 ft. wide, 9 ins. conc., re-enforced bars every 6 ft., at $206,000.

Mich., Mt. Clemens—Newberry & Weed awarded contract for 3 mi. slag base and gravel top rd. in Armanda Twp., at $18,532; 6 mi. of pavement in Warren Twp., to Jas. A. McKay & Son, Detroit, at $148,176.

Minn., St. Paul—Thornton Bros. Co., St. Paul, awarded contract for 2 miles brick paving on Concord St., South St. Paul, at $120,000.

Mo., Independence—J. P. Kealy, awarded contract to pave rock asph. 5 miles of road from Hickman Mills to Longview Farm, at $171,000.

Mo., Monticello—C. P. Reilly & Co., **St Louis**, Mo., awarded contract for 8.37 miles State Rd. from Canton southward and westward; also 8.94 miles State Rd. northward and southward thru LaGrange Special Rd. Dist., at $221,000.

Mont., Glendive—McGuire & Blakesley, Bozeman, awarded contr. for conc. paving at $88,000.

N. Y., Binghamton—Municipal Constr. Co., U. C. N. B. Bldg., Utica, awarded contract for paving Vestal Ave. (bitulithic) at $74,478.

N. Y., Franklinville—Morgan & Bock, Olean, awarded contract for paving Pine, Chestnut and Maple Sts., at $73,497.

N. Y., Fredonia—Oatka Engr. Co., Warsaw, awarded contract for section improved hwy. betw. Chautauqua and Mayville, 3.75 miles, at $112,874.

N. Y., Fulton—Louie Constr. Co., Meriden, Conn., awarded contract for impvt. of streets here at $176,912.

N. Y., Hornell—Kennedy Constr. Co., Hornell, awarded contr. for paving Cottage Ave., Allen, Elm, Grand, Washington and N. Church Sts.; 11,000 yds. brick, at $63,259; Hornell St., Chaddock Ave. and Adsit Pl. macadam, $15,308 to L. Dennison, 162 N. Main St., Bemis Ave., and Adsit Pl. conc., $6,505, curbing and guttering Park, Oak, Davenport and Albion Sts., at $6,221.

N. Y., Lockport—Bd. of Supvrs. Niagara Co., let contr. for paving 12.25 mi. Lake Rd., conc., to G. A. Hitchcock, Clymer, at $290,584; 2.02 mi. Military Rd., in Niagara, conc., to F. J. Mumm Contg. Co, 176 Best St., Buffalo, at $48,547; 3.33 mi. Beach Ridge Rd., bitum. macadam, to Siller & Waite, Norwich, $55,839; 2.07 mi. Stone Rd., Hartland Twp., and 1.39 mi. Griswold St.; (Gilbert Corners) macadam, to F. H. Rhody, Albion, at $30,470 and $23,136, respectively.

N. Y., Niagara Falls—Board of Supervisors awarded following contracts: Military Rd., 2.02 mi., concrete, to F. J. Mumm Contracting Co., at $48,546; 12.231 mi. conc. on Lane Rd. to Geo. A. Hitchcock, at $290,584; Beach Ridge Rd. in town of Pendleton, 3.33 mi. to Siller & Waite, at $55,839; F. H. Rhody, Stone Rd. in Hartland, 2.07 miles at $30,470; Gilbert's Corners-Griswold Street rd., in Royalton; 1.39 mi. to F. H. Rhody, at $23,136; Mountain Ridge Rd., Sec. 2, in Lockport, .533 mi. to Louis H. Gripp, at $14,588; Cambria-Lockport Town Line Rd. in Cambria and Lockport, .3896 mi. to Roberts & Weahl, at $10,638.

N. Y., Rochester—P. H. Murray, Rochester, awarded contract for reconstructing Part 1 B of Kanona-Prattsburg Rd., 3.29 mi. at $79.124.

N. Y., Syracuse—Following contracts let: J. H. Gallup, awarded contr. for constr. of bitum. Topeka pavement with conc. curb in Spencer St., at $40,692; Brattle Rd., asph. and stone curb, to Guy B. Dickison, at $14,252; East Laurel, bitum. Topeka with conc. curb, to C. T. Hookway, at $10,009; Farmer St. asph. pavement with stone curb, to G. B. Dickison, at $9,145; Townsend Pl. bitum. Topeka with conc. curb, W. Gallup, at $4,390; Oak St. asph. with stone curb, F. J. Baker, at $20,661; Pattison St. asph. with stone curb, F. J. Baker, $10,650; W. Fayette, Nelson, to Wilbur, bitum. Topeka with conc. curb to F. J. Baker, $7,467; Vine St., Robinson to Pattison, F. J. Baker, at $6,029; Sedgewick Dr., asph. with stone curb, to G. B. Dickison, at $19,412.

N. C., Bessemer—Davis-Wilcox Constr. Co., awarded contract to pave several streets; 27,700 sq. yds. plain conc., rein. conc. or sheet asphalt, etc., at $85,000.

N. Y., Utica—Municipal Constr Co., City, awarded contract for paving Vestal Ave., at $59,005..

N. C., Jefferson—Turner-Martsoe Constr. Co., Warrensville, N. C., awarded contract in conjunction with McNeill-Allman Constr. Co., Jefferson, to grade and gravel surface 20 miles of roads and bridgs., at $140,000.

Ohio, Bucyrus—F. L. Battdorf, Kansas, Ohio, awarded contract for 6 mi. brick paved country roads in Chatfield and Sandusky Twps., Crawford Co., at $229,677.

Ohio, Columbus—Franklin Asphalt Paving Co., awarded contract for paving Neil Ave. at $111,420 and Cleveland Trinidad Paving Co., contr. for paving Third St., at $104,332.

Ohio, Columbus—Director of Hwys. Herrick awarded following road contracts: Crawford Co. job to Scott Constr. Co., Lima, at $232,802, brick constr.; Allen Co. 3 mi. Lima-Sandusky Rd., brk. to E. L. Reed, Defiance; Putnam Co. 1 mile Lima-Ottawa Rd., Kentucky rock asph. to Scott Constr. Co., Lima; half a mile Lima-Ottawa Rd. brk. to same contractors; Union Co. 4 mi. Marysville-Kenton Rd. macadam, to L. G. Rockholt, W. Mansfield; Clermont Co. 1.5 mi. Cincinnati-Chillicothe Rd., asph. to Hogan & Garrison, Milford; Lake Co. 1 mi. Painesville-Warren Rd., conc. to L. G. Booth, Painesville; Mercer Co., 2.5 mi. Celina-Greenville Rd., conc. to Lynn Constr. Co., Paulding; Wyandotte Co. half a mile Upper Sandusky-Marion Rd. 1 mile Upper Sandusky-Findlay Rd. and mile of Fostoria-Carey Rd., all brick, awarded to Newark Paving and Constr. Co., Newark.

Ohio, Marysville—Wm. C. Moore, Marysville, awarded contract for rebuilding Lancaster and Newark Rd., Fairfield Co., at $70,000.

Ohio, Washington—O. Junk, awarded contract for 6.24 miles rein. conc. roadway here at $190,000. Road extends so. from Ross Co. on Jackson pike and is 16 ft. wide.

Pa., Harrisburg—State Hwy. Dept. let following contracts: Clearfield Co., Coalport Boro., 4,085 ft. to Thos. J. Strickler, Huntingdon, $37,816; Bradford Twp., 16,074 ft. to Johnson & Kearns, Dubois, $118,848.

Pa., Harrisburg—Donald McNeil Co., Pittsburgh, awarded contract in Allegheny Co., for impvt. of Pittsburgh-Kittanning Hwy. extending 13,365 ft. from near New Kensington brdg. over Penn. R. R. to south Boro. line of Tarentum, Springdale Boro. at $129,825; Smethport Constr. Co., Union City, awarded contr. for Armstrong Co. improvement of 19,224 ft. on Kittaning-Franklin Rd. E. Franklin Twp. from Glade Run to intersect. of Route 71, at approximately $140,086.

Pa., Harrisburg—R. D. Richardson Constr. Co., Scranton, awarded contract by St. Hwy. Dept. for 789 ft. Hunlock Twp. Luzerne Co., at $19,892; 15,334 ft. Rimersburg Boro., Toby & Madison Twps., Clarion Co., to R. V. Baldwin, Coraopolis, at $12,291; 6,186 ft. Woodward Twp., Clearfield Co., to R. J. Delong, Williasmport, at $53,083; also 4,092 ft. Houtzdale Boro., Clearfield Co., at $38,501.

S. C., Florence—Southern Paving Constr. Co., Chattanooga, Tenn., awarded contract for constr. of 21 miles asph. street paving here, at approximately $1,000,000.

Tenn., Mt. Pleasant—Smith, Pitts & Co., local, awarded contr. for constr. of road from Lawrenceburg to Waynesboro, dist. of 15 miles, at $103,000.

Tenn., Nashville—Following contracts let by St. Hwy. Dept.: F. A. P. 63-B, Cherokee Co., grade 8.05 mi. State Hwy. 17 from Gallatin to Davidson Co. line; hand-placed base with rock asph. surface, to Moore Bros. & Carr, Columbia, Tenn., at $179,694; F. A. P. 65-A, Warren Co., grade 6.67 mi.

State Hwy. No. 1, from McMinnville to Cannon Co. line, stand. hand-placed base course with bitum. macadam penetration surf. to J. T. Calhoun & Co., Nashvile, Tenn., at $160,307; FAP No. 4, Bedford Co., betw. Shelbyville and Moore Co. line; surface treatment, to Theo Vogelsberg, Louisville, Ky., at $17,561.

Tex., Waco—Kuykendall & Shelton, Temple, awarded contract for bldg. Waco-Mexia Rd., at $77,955.

Tex., Wichita Falls—Wichita County, awarded contract by State Hwy. Dept., Austin, to construct 8.2 miles Hwy. No. 2, 18-ft. conc. pavement. Proj. 262, at $281,166.

Va., Richmond—Following contracts let by State Hwy. Comn.: 8.25 mi. bet. Pendleton and Louisa, to Allport Constr. Co., Richmond, at $202,165; Scott Co., 5 mi. graded rd. to Snead Constr. Co., at $61,522; Halifax Co., 10 mi. rd. bet. Vernon Hill & Houston to Perkins & Barnes, Blackstone, Va., at $28,840.

Va., Richmond—Kelley & McLain, awarded contract for impvt. of Franklin and 9th Sts.; A. J. Boyle, Baltimore, Md., Grave St. to Wingo and Deaner; terra cotta segment blks. Cost about $100,000.

Wis., Florence—Brogan & McGinley, Crandon, awarded contr. for constr. of Armstrong Creek-Florence Rd. Proj. 206, at $40,612; also contract for constr. of Irma Gilbert Rd. Proj. 223, at $43,644.

Wis., Green Bay—F. P. Coughlin Constr. Co., Chicago, awarded contr. for asph. paving on Shawano Ave., Elmore St., School Pl., at $150,000.

Wis., LaCrosse—State Hwy. Comn. has decided to award contract for Fed. Proj. 136, Viroqua-Prairie du Chien Rd., Vernon Co., to Campbell Constr. Co., Minneapolis, at $78,069; Ross Paulson, Granton, Wis., awarded contract for FAP 214, Black River Falls-Millston Rd., at $60,372; 18-ft. shale surfacing, 11.3 miles in length.

Wash., Olympia—C. E. Davison, Roundup, Mont., awarded contract for impvt. of Pend Oreille Hwy., —Cusick to Locke—7.05 miles, at $47,962; Rich & Markus, Missoula, Mont., awarded contract for impvt. of Inland Empire Hwy., Yakima Co., 6.55 miles—Buena to Dalton, at $167,004; Campbell-Wilson Co., Sunnyside, Wash., awarded contract for impvt. of Inland Empire Hwy., 3.80 miles—Dalton to Granger—at $31,772.

Wash., Walla Walla—Pacific Coast Paving Co., awarded contract for constr. of Donahue Rd., from Prescott to Eureka, at $93,918.

Wis., Waukesha—Wilson-Johnson Constr. Co., Appleton, awarded contract for impvt. of Oconomowoc-Dousman Rd. Hwy. 67, at $86,751; 6 mi. conc. surf. Dousman Rd. to Robt. L. Reisinger Co., 464 Oakland Ave., Milwaukee, at $15,232, 1 mile surface.

SEWERAGE AND SEWAGE TREATMENT

B. C., Kamloops—Kamloops Plumb. & Heat'g Co., awarded contract for constr. of east end sewer at $47,980.

B. C., Vancouver—Nicholas Cosco, 1,367 Seymour St., awarded contract for constr. of approx. 1 mile of sewers in Point Grey, mostly in the Strathcona Dist., at $28,736.

D. C., Washington—Warren G. Brenizer, awarded contract for constr. of Conn. Ave. sewer at $1,780; Broad Branch trunk in Nevada Ave., from Chapel Rd. to Legation St., at $31,004; also Newark St. comb. sys. from Reno Rd. to 33rd Pl., at $2,576; Adam McCandlish, contr. to construct O Street replacement in O St. from 1st to N. J. Ave. at $4,045.

Fla., West Palm Beach—The Hanberry Constr. Co., Miami, awarded contract for Sewer Dist. No. 3 at $30,645; Sewer Dist. No. 4 to L. E. Michler, at $18,692.

Ga., Atlanta—Following contracts for sewer work let by Clark Donaldson, Engr. of Sewers: Wood Rucker Constr. Co., for Orne St. sewer at $126,000; J. B. McCrary Constr. Co., Highland Ave., sewer at $5,000; McDougald Constr. Co., for san. outfall sewer in Los Angeles Ave., at $16,485; Meadow Constr. Co., to extend Whitehall Street trunk sewer from Donally Ave. to Holderness St., at $28,106.

Iowa, Ames—Sorenson Drainage Co., Slayton, Minn., awarded contract for outfall sewers at $9,000; sewage treatment plant to Nelson and Aldrich, Spencer, at $48,742.

Ky., Louisville—Chas. F. Smith, Dayton, Ohio, awarded contract to construct Sec. E. of Middleton branch project in Cherokee Park, at about $25,000.

Mass., Boston—Wm. Barrett Co., awarded contract for sewerage works in Farragut road extension, South Boston, at $23,925; Timothy Coughiln, for sewerage works in Beverly St., Causeway St. abt. 339 ft. northwest, city proper, at $5,688. Jos. T. McCabe, awarded contract for sewerage works in B and 7th Sts., overflow extension, So. Boston, at $27,052.

Mich., Detroit—Hammen & Co., Mankato, Minn., awarded contract for 15,245 ft. 8-in. vit. crock sewer in Dix Ave., for Dix-Ferndale Land Co., at $25,000.

Mont., Deer Lodge—R. M. Barsden & Co., awarded contract for constr. of sewers in Dist. No. 68 on west side, at $16,498.

Mont., Glendive—Jas. Kennedy, Fargo, awarded contract for storm sewers at $58,000.

Neb., Omaha—Following contracts let for sewer work: 1-Dists. 739 & 733, Connolly & Fitch, $2,742; (2) Dist. 651, Gus Carlson, $4,867; both Omaha; (3) Dist. 633, Dunnegan & Briggs, Shenandoah, Ia., $41,405; (4) Dists. 738 and 630, Omaha Sewer Const. Co., Omaha., $20,000.

N. J., Paterson—Arnold More Co., Newark, awarded contract for installing sewer connections here, at $26,000.

N. J., Jersey City—Holbrook, Cabot & Rollins Corp., 52 Vanderbilt Ave., New York, awarded contract by Passaic Valley Sewerage Commrs., for continuation and completion of Sec. 2, outfall pressure tunnel, beneath portion of New York Bay and Jersey City, at $2,124,525.

N. Y., Durham—A. H. Guion & Co., Gastonia, N. C., awarded contract for sewers at $15,000.

N. Y., Long Isl. City—H. J. Mullin Constr. Co., Inc., Jamaica Ave. & 44th St., Jamaica, awarded contract for sewer in Norwood Pl. (166th St.) at $311,855 (Proposal B).

N. Y., New York—Pres. Bronx Boro. let contract for sewer in White Plains Rd., etc., to J. L. Sigretto & Co., Woodhaven, at $47,446; storm water drain in E 233rd St., to Anita Constr. Co., 2975 Marion Ave., $98,892; rebldg. existing conc. culvert across and under Gun Hill Rd., etc., to C. W. McDonald, W. 10th St., Brooklyn, at $9,295.

N. Y., Syracuse—Sam Palmisana, awarded contract for 17th Ward sewer system, at $25,815.

Okla., Waynoka—E. W. Eby, Wellington, Kans., awarded contract for constr. of sewer system here, at $28,749.

S. D., Timber Lake—W. B. Carter, 606 United Bk. Bldg., Sioux City, awarded contr. for construction of sewer system at $25,887.

Tex., Kerrville—McKenzie Constr. Co., San Antonio, awarded contract to construct sewage disp. plant at American Legion Sanitarium, at $37,345.

Wash., Seattle—F. N. Badolato, awarded contract for W. Dawson St. et al. sewers, clay pipe except item 4, which shall be 15-inch conc. pipe and using 45-inch premoulded conc. sewer (item 9), at $137,453.

Wis., Appleton—Wilson Co., awarded contract for contstr. of sewers in First, Fourth and Sixth Wards, at $16,639.

Wis., Fond du Lac—Geo. W. Mulholland Co., Rockford, awarded contract for constr. of approx. 1.5 miles strm and san. sewers at $13,628.

Wis., Milwaukee—Patrick Garahan, Racine, awarded contract for sewers by Garden Homes Corp., at $13,387.

Wis., Milwaukee—Du Pont Engrg. Co., Wilmington, Del., awarded contract for sedimentation and aeration tanks at Jones Island sewage disposal plant, 95,000 bbls. cement, 154 tons sand and 10,000,000 lbs. reif. steel.

Wis., Spooner—Pastoret Constr. Co., 308 Sellwood Bldg., Duluth, awarded contract for sewerage system, including 25,243 lin. ft. 6-15 in. sewer pipe, 68 manholes, one comb. manhole one inspection pipe, sewage treatment plant, steeling tank, sludge bed and appurts., at $44,000.

WATER SUPPLY AND PURIFICATION.

Cal., Glendale—Peter L. Ferry, 614 E. Acavia, Glendale, awarded contract at $3,600 ft. laying

1,100 ft. 4-in. and 600 ft. 6-in. c. i. pipe in San Fernando Rd., at $2,375 for laying 1,200 ft. Matheson pipe in 10th St and at $15,210 for 5,000 ft. 8-in., 300 ft. 6-in. and 250 ft. 4-in. c. i. pipe in Grand Blvd. and Cerritos Ave.

Cal., San Francisco—Contr. for furnishing and delivering four 20,000 kva. elec. generators and accessory equipt. for Moccasin Creek Power Hetch Hetchy Proj. Contr. 80, to General Electric Co., Rialto Bldg., $260,285; four 25,000 h. p. impulse water wheel units with individual oil pressure sets, Contr. 79-A, to Pelton Water Wheel Co., 19th and Harrison Sts., $248,800; eight 36-in. gate valves with hydraulic operating cylinders, Contr. 79B, to Coffin Valve Co., Monadnock Bldg., $37,580.

Que., Quebec—Following contracts let by Waterworks Comm.: Valves, Drummond, McCall & Co., Ltd., at $9.85, $16.85 and $28; cast iron pipe, Canada Iron Foundries, 4-in., $54.50, 6, 8, and 12-in., $50; lead pipe Mechanics' Supply Co.; pig lead, Carne, Ltd.; clay pipe, Standard Clay Products; Cast iron, Terreau & Racine; total cost of contracts, $50,000.

Que., Almaville—F. X. Brouillette, Shawinigan Falls, Que., awarded contract (general) for construction of aqueduct system at $1,000.

Ill., Collinsville—Meyer Constr. Co., St. Louis, awarded contract for laying new water main from pumping sta. to Jefferson Ave., at $19,408. 10-in. main.

Iowa, Albert City—P. N. Cruse, Spencer, awarded contracts for pipe line, at $10,770; steel tower, tank, etc., to Chicago Bridge and Iron Wks., 3v W. Van Buren St., Chicago, at $4,600; Well, to Thorpe Bros., 209 Goodrich Blk., Des Moines, at $1,525; pump to Motor Haulage Supply Co., Mason City, at $1,025.

La., Bossier City—McCalm Bros., Shreveport, La., awarded contract (general) for water works at $34,954.

Mich., Port Huron—American Constr. Co., Marion Bldg., Cleveland, awarded contract for impvt. and bldg. addns. to water works system, including conc. intake well, intake pipes, etc., at $41,500.

N. Y., Watertown—Northern N. Y. Untilities Co., 58 Pub. Sq., let contract for conc. dam and penstock saddles at Browns Falls to Amberson Constr. Co., New York; wooden penstock to Wood Pipe Co., New York; installing water wheel to Willman, Seaver & Morgan Co., Cleveland; elec. generative and switchbd. equipt. to General Elec. Co., River Rd., Schenectady—total, $450,000.

N. C., Elkins—Meyers Constr. Co., Charlotte, N. C., awarded contract for water and sewer construction at $24,500.

N. C., Lexington—Tucker & Laxton Co., Realty Bldg., Charlotte, awarded contract for constructing water works plant (pumps and pipe line not included) at $96,000.

N. C., Mt. Airy—City will build by Day Labor 26x24x8 ft. rein. conc. coagulating basin, 250,000 gal. filter unit complete (filter shell now in place), 25,000-gal. steel or wood wash water tank on 30-ft. tower with 8-in. pipe riser, same to be frostproofed and 1 liquid chlorinating apparatus. C. M. Whitlock, City Hall, Engr. Prices wanted on material and equipment.

Ohio, Cleveland—P. F. Connelly, Kent, awarded contract for 20,000 ft. 6-in. steel mains in Ansel Rd., to Fairmount Reservoir at $510,607.

Ohio, Elyria—Hunkin Conkey Constr. Co., Century Bldg., Cleveland, awarded contract for 60x137 ft. water basin, conc., at $50,000.

Ohio, Euclid—A. Mara, Ulmer Bldg., Cleveland, awarded contract for mains in Dorsch Rd., at $17,184; Victory Dr., Wood and Neville Rds., to B. J. Whittaker, 343 The Arcade, Cleveland, $7,307.

Okla., Oklahoma City—Following contracts let for iron pipe, etc., for water distribution system: U. S. C. I. Pipe & Foundry Co., bell and spigot pipe at $202,406; N. S. Sherman Mach. & Iron Wks., at $12,187 for special fittings for pipe and $870 for valve castings; Darling Valve & Mfg. Co., at $22,154 for hydrants and valves.

Okla., Weleetka—Ladd Constr. Co., P. O. Box 6, Kansas City, Mo., awarded contract for constructing 5-mile pipe line, low-lift pump station, 500,000-gal. per day water purification plant and clear pumps, 1 mile transmission line, overhauling elec. distribution system and 25 pole white way, at $72,005.

S. D., DeSmet—O. N. Gjellefald Constr. Co., Forest City, Ia., awarded contract for water works system, including 23,550 lin. ft. 6-10 in. Class B c. i. pipe, 21,000 lbs. specials, conc. or steel tower, 150,000-gal. capy. pumphouse, conc. well, etc.; also sewerage system, at $95,500.

Tex., Houston—Chas. S. Basham, awarded contract for erection of settling tanks at Houston Heights and West End plant, at $13,400.

Tex., Jacksonville—Contracts for water works let as follows: E. P. McElrath, Corsicana, at $40,363 for Contr. No. 1; Robert C. Newcomb, Dallas, at $29,994; U. S. Cast Iron Co., Dallas; Darling Valve Mfg. Co., Williamsport, Pa.; Briggs Weaver Mfg. Co., Dallas; Maury & Maury, Dallas; Des Moines Steel Co., Pittsburgh, Pa.

Tex., Marlin—Hess & Skinner, Dallas, awarded contract for constr. of dam and spillway at $58,867.

Va., Norfolk—Fred Jones Dredging Co., awarded contract for submerged pipe across Elizabeth river from Craney Isl. to Lamberts Point filter station, at 48c a yd. for dredging; for laying pipe, contract let to Sanford & Brooks at $14.50 a ft. Total cost, about $60,000.

Va., Richmond—Virginia Equipment & Supply Co., Richmond, Va., awarded contract for water main at $89,965 and at $18,660 for gas main.

Wis., Delavan—Swords Bros., 7th St., Rockford, Ill., awarded contract for exten. to water works, including ½ mile 8-in. force main, pumphouse and 30-ft. open well, at $16,782.

Wis., Milwaukee—Contract for 6,900 tons c. i. pipe and 30,284 tons special castings for force main in Chambers and 29th Sts. (a) straight (b) lugged (c) special castings, to U. S. Cast Iron Pipe & Fdry. Co., 122 S. Michigan Ave., Chicago; (a) $40.85 per ton, (b) $60.86, (c) $118; 54-in. main in Chambers St., to W. T. Warner, 645 Hi Mount Blvd., $76,235; 36-in. main in 29th St., to L. J. Stevenson, 1720 Cedar St., $17,080.

Prospective Work

ROADS AND STREETS

Ala., Attalla—City plans expendt. of $125,000 for purpose of paving 30 blocks; bitum. macadam, penetration method.

Ala., Tuskegee—Government will construct roads and bridges from city limits to site of U. S. Veterans' Hosp. to be built. $200,000 available. Jas. R. Fain, Supt. Rd. Constr. for Treasury.

Ark., Pine Bluff—City Commrs. Paving Dist. No. 59 plans expending $60,000 to pave 25 blks. in Hickory, Cypress, Plum and Cedar Sts. Guest Engrg. Co. Engrs. City Commrs., Paving, Curb & Gutter Dist. 57 will pave 18 blocks on 14th Ave., Oak, Beech and 11th Sts.

Ariz., Phoenix—E. S. Wheeler, Engr., Dist. No. 13, Phoenix, U. S. Bureau Pub. Rds., has ordered surveys for approx. 113 mi. rds. in Arizona and New Mexico, to be built with fed. funds. New Mexico projects are as follows: Canyoncito-Pecos, 18 ft. surfacing, 12 miles; Cimarron-Toas, 18 ft surfacing, 18 miles; Silver City-Reverse, 16 miles, 14 ft. wide with surface. Arizona projects: Prescott-White Spar, 18 mi.. Est. cost, $500 per miles; Ashfork, 26 miles to boundary of forest reserve; Flagstaff-Angell, 23 miles. Total est. cost, $1,250,000.

Cal., San Diego—Council has adopted resolution of intention for street work as follows: E Street—30th to 31st Sts.—to be improved by grading, constructing conc. walks, curbs and 8-in. cem. pipe culvert; State St.—Redwood to Quince Sts.—to be graded and paved with one-course cement concrete; portions of Grade and Dront Sts., to be improved by paving with asph. conc. wearing surf. on asph. concrete base; also one course conc. in certain sections; constructing conc. walks and culverts. Third St.—Walnut to University Aves.—to be paved with asph. conc. wearing surface on asph. conc. base; portions of 8th and A Sts, to be im-

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson.
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

proved by paving with asph. conc. wearing surf. on cem. conc. base, constructing curbs, house connection sewers; Roosevelt Memorial Dr. bet. Pueblo lot 1286 and existing pavement at ft. of Biological Grade, to be improved by grading, paving with one course cem. conc. and constructing cem. conc. bearms.; 35 ft. 18-in.; 27 ft. 24-in. and 30.75 ft. 60-in. corr. iron culvert; Iowa St.—University to Polk Aves.—to be paved with asph. conc. wearing surface on asph. conc. base; Torrey Rd.—Prospect Pl. to Princess St.—to be improved by grading, paving with one course cem. conc., constructing conc. curbs, walks 52 ft. 18-in. corr. iron culvert; also 30 ft. of Roosevelt Memorial Dr., by grading and paving with one course cem. conc., constructing 50-ft. 24-in., 37 ft. 18-in. and 48 ft. 24-in. corr. iron culverts; Herman Ave.—University to Thorn St.—to be improved by paving with asph. conc. wearing surf. on asph. conc. base, constructing conc. curbs and walks; 12 ft. 16-in. conc. pipe, 19 ft. 16-in conc. pipe, 338 ft. 18-in. double strength conc. pipe, 12 ft. 15-in. corr. iron pipe.

Cal, Vallejo—$438,000 will be expended toward constr. of state highways in Solano Co. during 1922.

D. C., Washington—House passed Dunn bill appropriating $140,000,000 for road work for next two years.

Idaho, Pocatello—Four short links in constr. of North and South state hwy. will be finished this Summer. First of these is 2.75 mile stretch on Caldwell Blvd., 2nd, 2.91 mi. no. on Boise Hwy. Grade is to have width of 26 ft. and surf. 18 ft. Est. cost of two links, $32,219. Culvert draing. will cost abt. $2,000 additional. A stretch of more than 20 mi. bet. Tamarack and Council will be another of the main links to be finished. Nine miles bet. Lucile and White Bird, along canyon of Salmon River, will also be built this summer.

Ill., Peoria—Ten miles hard rd. will be built from Canton East to Peoria and 10 miles from Rushville toward Beardstown this summer; also 6 miles no. of Macomb on Monmouth Rd. within one mile of Good Hope.

Kans., Wichita—Definite action toward paving No. Lawrence Rd.—City limits to Sedgewick-Harvey Co. line—taken by Co. Commrs. when they passed two resolutions asking St. Hwy. Comn. to take immediate steps toward regrading grade crossings of Santa Fe and Frisco Ry. roads no. of City. M. Roseberry, Co. Engr., announced that County expects to let contract for the paving before July 1st. Proj., including 1 r. r. viaduct, will cost approx. $600,000.

Md., Baltimore—City Paving Comn. has plans ready for paving 55 streets. Est. cost $1,400,000. R. K. Compton, Chrmn.

Mass., Boston—Approx. $153,000 will be expended this Summer for resurfacing Humboldt Ave. and Blue Hill Ave., bet. Seaver St. and Milton line in Roxbury. Bitulithic surfacing. Mayor has also promised that, if funds are available, he will carry thru as far as possible the laying of new granite paving in Warren St.—Dudley to Grove Hall. He has also made tentative arrangements with Pub. Wks. Commr. J. A. Rourke for expendt. of an additional $80,000 for street repairs in North and West Ends.

Mich., Holland—City Engr. instructed to prepare plans and specfs. also estimate of cost on paving 7th St.—Lincoln Ave. to Pine, and then connect 7th and 8th Sts. on Pine and Lincoln. Macadam base and sheet asph. top dressing will be used.

Minn., Olivia—40 miles of road will be graded and improved this Summer in Renville Co. Co. Surv. J. M. Callahan; Co. Aud. A. O. Schmidt.

Mo, Columbia—Council has passed resolutions for paving Paris Rd., Melbourne St. and S. 5th St., with Kentucky Rock Asphalt. It is hoped to let contract in near future.

Nev., Carson City—Plans have been completed on Project No. 10, Robinson Summit to Illipah, White Pine Co., 15 miles grading and gravel surfacing; No. 44, Illipah to Pancake Summit, White Pine Co., 23 mi., grading and grav. surf.; No. 45, Frenchman's Flat, Churchill Co., 5 mi. grading and grav. surf.; No. 15 West Co. line to Vivian, Elko Co., 8.34 mi. grading; No. 22, West Co. line to White House, Eureka Co., 6 miles, grading and grav. surf.; No. 31, Eureka to Hayranch, Eureka Co., 12.2 mi. grading and grav. surf.; No. 4, 3 mi. no. of Carters to Holbrook, Douglas Co., 4 miles grading and 25 per cent surfacing. Plans being prepared for Proj. No. 26, Reno to Lawtons, Washoe Co., 4 mi. grading and grav. surf.; No. 16, Battle Mtn., Lander Co., 8.5 mi. widening grade and gravel surf.; No. 46, thru City of Yerington, Lyon Co., 1.5 mi., 18-ft. conc. surf., thru City of Fallon, Churchill Co., 1.24 mi., 18-ft. conc. surf., Hazon to Wadsworth, Lyon, Churchill and Washoe Co.'s, 15.65 mi. grading and gravel surfacing. Surveys completed on Rd.—Hazon to Wadsworth, Lyon, Churchill & Washoe Co.'s; thru City of Yerington, Lyon Co. and thru city of Elko, Elko Co. Surveys being made on Dallon to Grimes Ranch Rd., Churchill Co., Rose Crj. to Winnemucca Rd. Humboldt Co. and thru City of Winnemucca, Humboldt Co. Geo. W. Borden, St. Hwy. Engr.

N. M., Roswell—City Council has passed provisional paving order, which, if carried out in its entirety, will result in 41 new blocks paving being built here

N. Y., Brooklyn—Board of Estimate O. K.'s paving, grading and sewer plans, as follows: Paving with asph. (perm.) Bay 32nd at est. cost $10,900; regulating and grading Narrows Ave., $19,200; regrading, recurbing and reflagging portion Hegeman Ave., $2,200; paving with asph. (perm.) portion Conselyea St., $6,300; regulating and grading Hinsdale St., $6,600; asph. paving (perm.) on portion 48th St., $8,700; paving with asph. (perm.) on Kenmore Pl. $7,000; asph. paving (perm.) on Ave. K., $10,500; asph. paving (perm.) on portion 19th Ave., $7,200; asph. paving (perm.) on 61st St., $7,600; asph. paving (perm.) on 71st St., $6,600; asph. pavement (perm.) Kenmore Pl., $8,500; asph. pavement (perm.) on E. 14th St., $11,000. Work includes bitum asph. (prelim. pavement) from Gravesend Neck to line abt. 260 ft. so. of Ave. U; granite paving (perm.) on Dupont St., $11,650; asph. pavement (perm.) 50th St., $7,800; regulating and grading Kenmore Pl., $3,700; paving with asph. (perm.) Newkirk Ave., $4,900; paving with asph. (perm.) and curbing where necessary Kenmore Pl., $18,100.

N. Y., Poughkeepsie—City Engr. Lawlor estimates cost to property owners of new pavement on Main St. from river to Cherry St. at abt. $40,000 for cut granite blks. on lower Main St. and comb. of first quality street asph. on sides of street and cement for trolley rails from Wash. St. east to Cherry St. Total cost placed at $140,000 of which $61,000 is trolley company's share. Business men held special meeting to name committee to co-operate with City administration in having this necessary improvement made.

Ohio, Columbus—There will be 60 street constr. jobs under way this month, 39 of which have started. Plans and specfs. for 61 others have been approved and notices are being served. In addition to these Council has asked for estimates on 63 more. Mr. Simpson, City Engineer.

Tex., Karnes City—Karnes County Rd. Dist. No. 4 will construct 14.54 miles 1-in. bitum. surf. on gravel and caliche base; 1,460 sq. yds. pavement; 1,400 cu. yds. concrete. Est. cost $325,000. O. N. Powell, Engr. Kenedy, Tex.

Tex., Laredo—Bonds in sum of $150,000 voted on favorably in Webb Co. for purpose of bldg. highway from Laredo to Mirando City oil fields.

Tex., Sequin—Guadalupe Co. Rd. Dist. No. 5 will grade and gravel 3.7 miles, and hard surface 19.1 miles in County at cost of $120,000. Hess & Skinner, Engrs. Dallas for 3.7 miles. J. B. Williams, Co. Judge.

Va., Norfolk—Norfolk County Rds. & Bridges Comn., will improve Swamp Rd.; construct Atlantic Ave. from Va. Ry. crossing to Edmonds' corner; macadam surface; construct permanent surface on Swamp Rd. from Edmond's Cor. to intersect. of Great Bridge Blvd. at Oak Grove Church; conc. Plans issuing $110,000 bonds.

Va., Petersburg—Approx. $2,000,000 will be expended on impvts. here during next 12 months.

Wis., Milwaukee—City will pave about 200 alleys this Summer if plans of Bd. of Ets. are carried out by City Council.

Wis., Milwaukee—State will construct opprox. 200 miles concrete highways during Summer and Fall in Milwaukee and adjoining counties. A total of abt. 400 miles paved road will be built this year. A. R. Hirst, St. Hwy. Commr.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers, and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Muhicipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

WATER SUPPLY AND PURIFICATION

Ariz., Prescott—Bids will be asked in about 30 days for constr. of the Banning Crk. dam, to be built as an adjunct to Prescott water system. It will be of concrete constr., 20 per cent cyclopean mas. type, 292 ft. long, with wing wall sustaining the spillway 225 ft. long, 62 ft. high, 6 ft. at top with base, 42 ft. Est. cost $150,000. City Engr. A. J. Kline has prepared plans.

Cal., East San Diego—City Engr. has reported to City Council that est. cost of proposed water system will be $260.000. E. A. Rowe, Hydr. Engr., representing J. B. Lippincott, water expert, reported that distributing system as planned is scientifically correct

Cal., Santa Barbara—Montecito County Water Dist., having ests. made as to cost of installing and maintaining distributing sys., in newly created district. City Council of Santa Barbara considering proposal to sell District water from city's supply.

Que., St. Raymond—Plans being prepared for water works system to cost $250,000 for town. Engr. Lapointe, Baire, St. Paul.

Fla., Auburndale—$30,000 bonds voted here for water works. W. L. Mason, Clerk.

Ky., Newport—City has decided to enter into contract with Geo. Hornung, Civ. Engr. to supervise installation of a 6,000,000 gal. pumping engine at Newport pumphouse.

La., Lake Arthur—Town will construct water works and purchase power plant for electricity. $50,000 bonds voted.

Md., Cumberland—City will extend feed main, probably abt. 8,000 ft. of 36-in. pipe line. Jas. H. Fuertes, 140 Nassau St., New York City, Cons. Engr.

Mich., Detroit—Essex Border Utilities Comn. plans to supply border municipalities with filtered water which will come to Windsor, Ont., by gravitation thru 36-in. pipe. J. C. Keeth, Engr. Plans will have capy. of $35,000,000 gals.

Minn., Lake City—City Council has decided to lay 85 blocks water mains for purpose of providing additional fire protection and to give all residences in City opportunity to have city water. Est. cost of impvt. $53,000. Plans call for laying 32,000 lin. ft. 6-in. water mains with exception of 750 ft. 4-in. mains on Park St.; also for 61 fire hydrants in addn. to the 84 now in, and 42 cut-out valves.

Mo., Versailles—$81,000 bonds sold here; $60,000 for water works and $21,000 for sewers.

N. J., Ventnor—Ord. creating bond issue of $200,000 for impvts. to water works, passed on second reading.

N. Y., Buffalo—City contemplates construction of filtration plant, plans for which include large coagulating basin, 304x408 ft. long and 24 ft. deep. Basin will hold approx. 20,000,000 gals. It is divided into two separate parts so that either may be drained and cleaned without taking other out of service. There will be 40 filter units, each having normal daily capy. of 4,000,000 gals. Low lift pumping station will contain 5 electrically driven centrif. pumps with total daily capy. of 240,000,000 gals. There will be 2 tunnels, approx. 12 ft. sq., one for conveying water from present intake to filter plant, and other to carry filtered water from filter plant to Ward pumping sta. In 2 huge conc. basins there will be over 1,000 conc. columns for support of overhead struct, large number of which will be 25 ft. long. There will be approx 340,000 cu. yds. earth excav. Much of this excav. will be taken from area now under water and used as backfill in vicinity of filter plant.

N. Y., Syracuse—City plans to lay 4,000 ft. mains in various streets at cost of about $75,000. T. H. Mather, City Hall Engr.

N. D., Fargo—Plans approved for constr. of water mains. Job 2204 Water Main Dist. 2, 15th St. N. from 3rd to 5th Ave.; Job 2205, Dist. 1, 15th St. S. from 1st Ave., 2nd Ave. 3rd to 4th Ave., 16th from Front St. to 2nd Ave. Job 2206, Dist. B, 11th St. S.—10th to 11th Ave. S.; Job 2203, Dist. 1, 14th, from 10th to 11th Ave. A. R Watkins, City Clk.

Okla., Ponca City—City will extend water works system; install 1000 gal. per min. centrif. pump 250 ft. head, 100 h. p., 2200 volt, 3 phase motor; approx. 1200 ft. 10-in. cast iron pipe.

Okla., Thomas—Surveys being made for pumping plant and wells to cost $50,000. H. G. Olmsted & Co., 415 Oil Exchange Bldg., Okla. City, Engrs.

Pa., Philadelphia—City will soon take bids for furnishing and installing pumping units at Larners Point Pumping Sta., $35,000; also for quantity of patent sleeves, stop valves and water pipe, $12,000. C. E. Davis, City Hall Engr. City will also take bids in near future for installing ash and coal-handling equipt. at Queens Lane Pumping Sta. $25,000.

Tex., Electra—Attorney General's Dept. has approved bond issue of $80,000 for water works and $20,000 for sewers.

Vt., Petersburg—City will extend water and sewer systems, constr. streets. $200,000 available. L. Brownlow, Mgr.

Wn., Monroe—Bids will soon be asked for water works system. Detailed plans and specfs. being completed by Miller Engrg. Co., Burke Bldg., Seattle. W. H. Clark, Town Clk. Monroe. Proj. will a 1,000,000-gal. conc. reservoir, laying 6 miles 8 and 10 inch wood stave main pipe line; also 32,500 lin ft. 4, 6 and 8 in. wood stave distribution lines, 425 cu. yds. conc., 8,000 cu. yds. excav. in main line and 6000 cu. yds. excav. in distribution system.

W. Va., Fairmont—City may expend $1,000,000 for water supply system. J. Clyde Morris, Water Commr.

SEWERAGE AND SEWAGE TREATMENT

Ca., Long Beach—A. L. Ferver, Director Pub. Service, reports that plans for addition to sewage disposal plant at entrance to harbor will be completed within 60 days.

Cal., Riverside—Resolution adopted by City Council to construct san. sewer in Hayes, Myers, Taft, Galloway, Roosevelt, Magnolia and other streets in Village of Arlington.

Fla., Key West—City contemplates constr. of san. and domestic sewerage sys. Est. cost $620,631. C S. Williams, Acting City Clk.

Md., Harve de Grace—Election will be held to vote on issuance of bonds for construction of sewer system. Mayor confident $35,000 will build sewer.

Miss., Durant—City will improve sewer system, $20,000 bonds voted.

N. J., Camden—Street Comm. has recommended to City Council that sewer be constructed for elimination of Baldwin's Run in E. Camden at cost of $275,000. Mr. Farnham, City Engr.

N. J., Jersey City—Vice-Chancellor Griffin has signed order permitting constr. of intermittent sand filtr. and chlorinating plant, to be used in connection with sewage disposal plant at Boonton.

N. Y., Glen Falls—$225,000 bonds voted for about 18 miles san. and storm sewers. L. G. Boynton, Clk.

N. Y., Gloversville—Plans and specfs. completed by Harison P. Eddy of Metcalf & Eddy, Cons. Engrs., Boston, Mass., for impvts. to sewage disposal plant so. of City. Est. cost $100,000.

N. Y., Massena—City voted on $65.000 bonds for storm sewers in various streets. G. W. Dawes, Vil. Pres.

N. Y., Queens Boro—Final plans and specfs. have been sent to Corp. Counsel's office for constr. of trunk sewer for Blissville section of Long Island City. Sewer will cost upwards of $150,000.

N. Y., Syracuse—City may expend between $300,000 and $400,000 for a digestive system to dispose of sludge from proposed sewage disp. plant. Ord. to this effect introduced by Alderman F. J. Cooney.

O., Cleveland—City plans new sewage disposal plant. Est. cost $240,000. F. A. Pease Eng. Co., Marshall Bldg., Engrs.

O., Port Clinton—W. J. Sherman Co., Toledo, O., have been assigned the work of preparing prelim. plans and estimates of cost for san. sewers, intercepting sewers and sewage disposal for Pt. Clinton.

Okla., Stroud—City will construct san. main sewers and sewage disp. plant; probably vote on bonds. City, Mo., Cons. Engrs.

Pa., York—Plans and specfs. for proposed addns. to sewage disp. plant completed by Fuller & McClintock, Cons. Engrs., New York City. Dr Grove, Supt. of Dept. Pub. Safety, recommended adoption of the plans and specfs., which will be submitted to Dept. of Health for approval.

BUYERS' GUIDE

Pumps.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Lee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
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Stone Screens.
Austin-Western Road Machinery Co., The
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Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Structural Steel.
Lewis-Hall Iron Works.

Subgrading Machines
Austin Machinery Corp.
The Hug Co.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

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Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
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Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
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Kirschbraun, Lester.
Nutting Co., H. C.
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Traction Engines.
Austin-Western Road Machinery Co., The

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Austin-Western Road Mach. Co.

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Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Electrical & Specialty Supply Co.
Little Giant Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

Turbines, Steam.
De Laval Steam Turbine Co.

Turntables, Truck
The Hug Co.

Valves.
Coldwell-Wilcox Co.
The Flower Company.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
The Flower Company.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Murphysboro Paving Brick Co.
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